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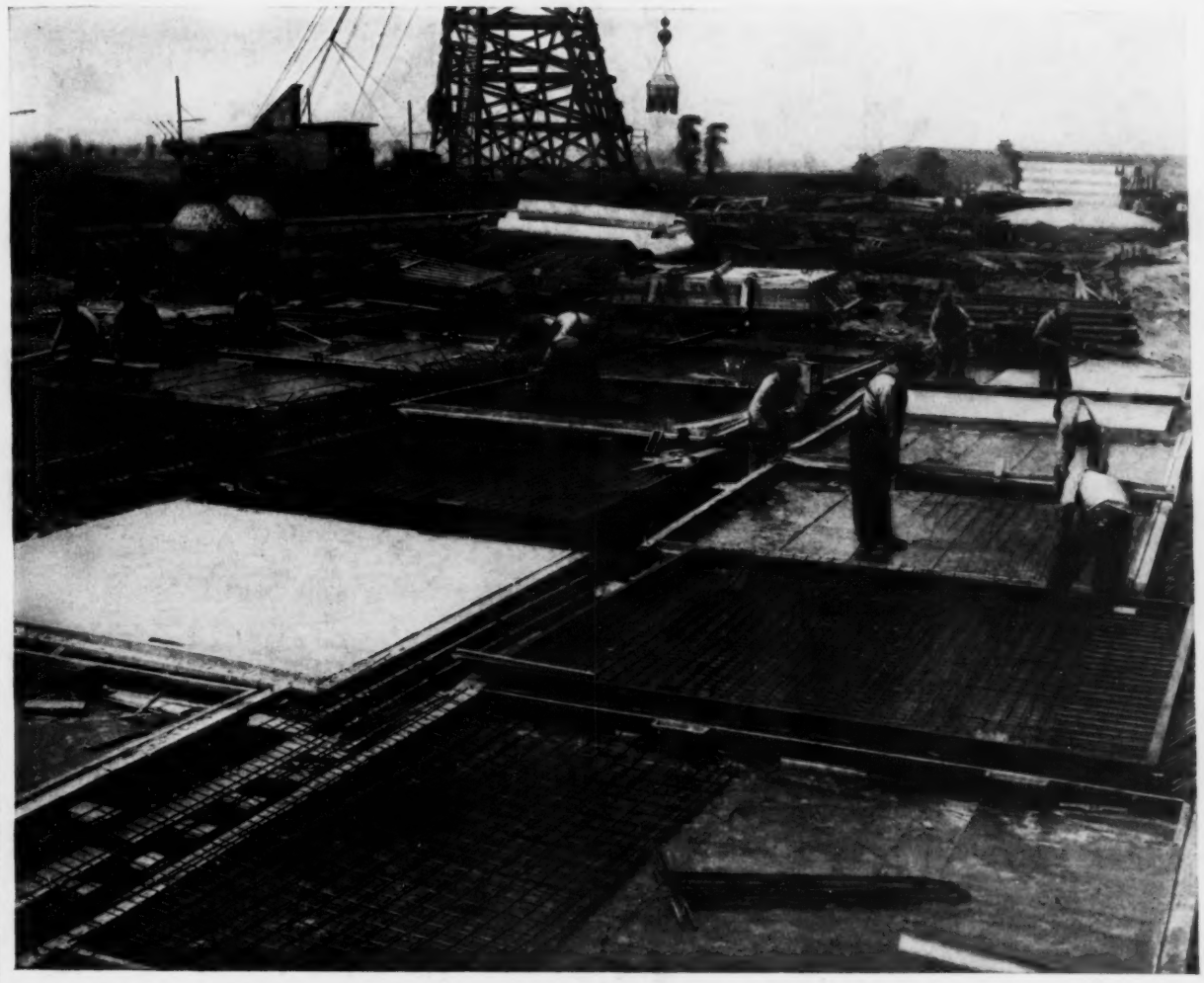
March 1, 1928

Engineering News-Record



Casting Baffle Walls, West Side Sewage-Works, Chicago

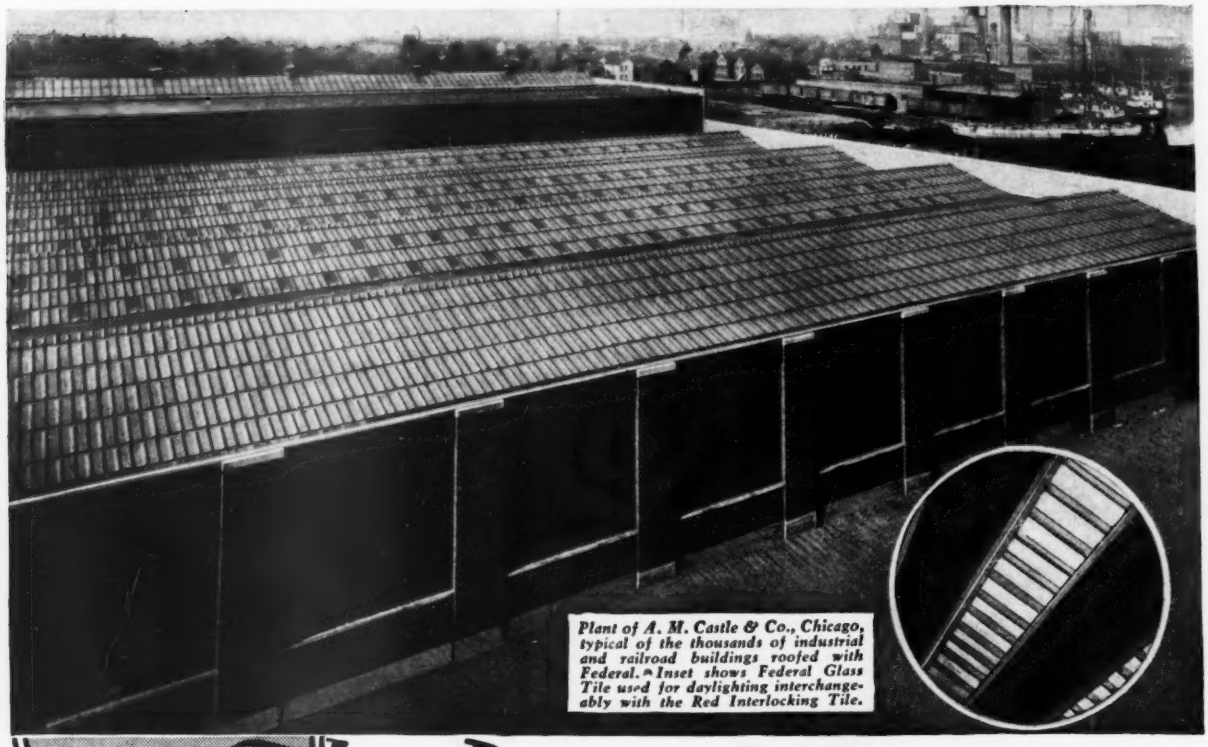
West Side Sewage-Works Construction at Chicago

Intake Tunnel Built by Novel Pneumatic Caisson Method

Widening Heavy Traffic Streets at Pontiac, Mich.

Po River Flood-Control Works

Oil-Well Pollution Necessitates Auxiliary Water Supply



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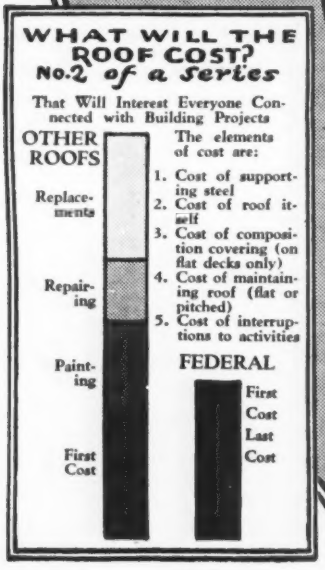

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Submarine Safety

COMMENDATION for courageous impartiality is due the naval court which investigated the tragic sinking of the submarine "S-4" off Provincetown last December. The findings lay blame equally on the commanders of the two vessels which collided, though one was a Treasury vessel and the inquiry was conducted by the Navy alone. If in this respect the court's report is gratifying, it is a disappointment in the way it deals with the question of submarine safety and salvage. There is, it is true, a recommendation that the question be studied by a technical board; but beyond this single paragraph there is no word in the whole report of the damning indictment laid against the Navy by the loss of the "S-4." The hopeless efforts to rescue the six men who for three days sent desperate signals for aid from their living tomb placed critical stress on the lack of thought given to the saving of life in submarine practice. Yet from the report one could not guess that submarines are built without hitches by which they may be raised when sunk, without dependable means of supplying air to their compartments, without emergency locks for entrance or exit. Let it be hoped nevertheless that these matters will now be subjected to searching study and that safer and humane practices will develop therefrom. Without such result the lives of the forty who went down with the "S-4" will remain but another fruitless sacrifice.

The Future of the Moffat Tunnel

MOFFAT TUNNEL has been completed and opened to permit the passage of trains under the Continental Divide, but the project of which it was to form a part—the putting of Denver on a transcontinental railway line—is as much of an uncertainty as ever. When David H. Moffat began the construction of the railway which is to be served by the new tunnel, he proposed to extend it through to Salt Lake City, thus making it possible to move freight west from Denver without first having to send it north to Cheyenne or south to Pueblo; but construction of that line was stopped at Craig, Colo., about 250 miles west of Denver. Completion of the project to Salt Lake City now is almost out of the question. To put the Moffat tunnel on a main route, therefore, necessitates construction of the 40-mile Dotsero cutoff, a connecting link between the Denver & Salt Lake Railway and the Denver & Rio Grande Western in the Colorado River canyon. This line, connecting with the Western Pacific and the Denver & Rio Grande Western on the west and with the Chicago, Burlington & Quincy on the east, would give Denver a through east and west railway. But there are some formidable obstacles in the way of its construction. The line would have distinct advantages for the D.&R.G.W. were it not for the division of freight rates with the Denver & Salt Lake, and also the fact that the D.&R.G.W. is controlled jointly by the Western Pacific and the Missouri Pacific and that the latter would stand to lose freight by the construction of the cutoff. The Burlington appears to stand to gain the most by the construction of the cutoff, but it could not undertake it without first gaining control of the Denver & Salt Lake. The latter railway is too poor to finance the work alone, especially when it has no reasonable assurance that traffic originating off its own line will be routed that way. Construction of the cutoff is a matter of great concern for the improvement district, which built the Moffat tunnel. It has about $18,000,000 invested in the latter project. Possibly it may have to finance construction of the cutoff in order to insure getting an adequate return upon the money it has already spent on the tunnel.

Public Health Service Engineers

FEW people know that there are now some twenty-five sanitary engineers in the U. S. Public Health Service; fewer still know that these twenty-five and other technically trained members of the Health Service staff have not the same status as the medical men in that branch of the government. For years past an effort has been made to provide for the commissioning of these engineers. This movement is now combined with a broader one for co-ordinating the public works of all government departments and increasing the activities of the Public Health Service, including the Hygienic Laboratory, in proposed legislation (H.R. 11,026) outlined in our news pages for Feb. 23, 1928, p. 336. Since that note was written the bill has been favorably reported to Congress by a unanimous vote of the committee to which it was referred. The prospects for the early passage of the bill are good but would be increased by the support of engineers and others throughout the country. Such appeals should be addressed to members of the lower house, especially the representatives of those making the appeal. The cause is doubly worthy, as it is designed to benefit not only the engineers and other technically trained men in the Public Health Service but also the public health throughout the United States and its possessions.

New Practices in Concreting

AS AN example of plant layout and equipment use in construction the operations at the West Side sewage-works of the Sanitary District of Chicago, which are described in this issue, deserve attention. Two of the operations merit special emphasis. Concrete is being handled by belt conveyors more extensively than in any previous work of construction that comes to mind. It has been handled well. With very close quality control by the engineers, there have been few instances where segregation, the presumed great hazard of belt conveying, gave anxiety. In these instances the trouble was found due to irregular feeding of the belt. With steady con-

tinuous delivery to it of the mixture, travel on the belt and tripping from the main conveyor to lateral conveyors resulted in no material separation of the coarse aggregate from the mortar. Second in interest was the use of precasting to save time and difficult form handling in constructing the baffle walls of Imhoff tanks. The molding of these thin members, with their close-mesh steel, has always been regarded by the contractor as the most fussy task of all his concrete work in Imhoff tank construction. Guniting, on an underform only, has offered a decided relief from the uncertainties of pouring between double forms. Now at the Chicago operation the innovation has been undertaken of building up the walls of precast slabs and thus eliminating all form work. Soundness of slab structure is assured by having the pouring always under observation and the whole broadside of the slab open for puddling the concrete around the steel. The lifting and carriage of the slabs from casting yard to place in the tank structure provide automatically a test of strength. A final possibility is increased speed. With the slabs cast well in advance, their fabrication into a finished wall is a quick operation compared with the processes that have been previously employed in baffle-wall construction. Whether the laid-up walls with many joints will remain tight and whether breakage of slabs in handling is a burdensome item are among the queries which constructors will be looking to the Chicago sewage-works to answer as experience develops.

Strength Against Storms

IN THE periodic sweep of tornado or hurricane across the earth, men have succeeded only indifferently well in gaining quantitative knowledge of storm power and the resistance of structures. More progress is being made in these modern times; and especially in the recent rise of the spirit of study and research are we approaching the goal of more confident ability to combat storm fury. More confident and at the same time more questioning—for we recognize more fully the difficulties which storm violence and the intricacy of modern construction present. A noteworthy contribution to the subject is published in this issue, the report of a committee which investigated the damage wrought by the great Florida hurricane of Sept. 17 and 18, 1926. In reading this report it will be readily apparent that in addition to giving valuable information it opens up many new questions, which require early answer if we are to profit fully from the storm teachings. By careful analysis of the major building failures resulting from the storm, the committee finds that they resulted from a number of constructional deficiencies—by no means wholly exceptional in city building construction—and gives warning of a number of obscure points in the engineering design of building frames. The facts brought to light invite extended comment, but this must be deferred to another time. For the present we express our gratification at noting that the committee's findings confirm many of the views stated by us just after the storm, when a staff representative had visited the devastated region. The stimulus which the report promises to give to structural study is of such value, particularly at the present time, that the committee's work will take high rank in the lilterature of engineering knowledge concerning storms. It is worthy of close study by all who are concerned with structural design.

Hard Times and Public Works

A HOPEFUL attack is being directed against the world-old evil of hard times, which still is with us in spite of all the advance of civilization. Men of industry and business are giving the problem careful thought. In Congress the same interest finds expression in a bill of Senator Jones, of Washington, to establish a reserve fund for use in carrying on public-works construction during times of depression. That a problem so profound in its human importance should engage the interest of the national legislature is proper ground for gratification. During long centuries statesmen have made it their concern.

Periodical depressions, the bad years coming after the good, have been known since history began, and every wise ruler in turn has felt the ambition to abolish them and bring about lasting well being among his people. It is quite likely, indeed, that these ambitions were potent factors in shaping the world's history, political as well as economic. Yet the problem has remained. Cycles of good and bad times still come and return. But we are today an industrial world, and the nature of the problem has changed. Our prosperity is not menaced by crop failure and famine, but by obscure phenomena of human and economic kind, involving financial solvency, commercial soundness and public confidence. These are man-made factors, and as such they should be subject to man's control, it would seem.

Not only is the modern problem of business depression composed of elements that we may reasonably hope to bring under control but it lies within the range of powerful modern resources—economic and financial science, and the arts of production and commerce. If the kings of olden times could devise only relief measures, such as great granaries in which to guard the surplus produce of prosperous years against the time of famine, our modern opportunity is greater. We may be able to achieve prevention as well as cure. Ultimately, at least, we may succeed in damping out the pendulum swings that lead from feverish production to stagnation and misery; this will be complete prevention. Meanwhile we may be able to devise expedients to limit the unbalance of economic forces—curative expedients.

One of our great business leaders dwelt thoughtfully on this theme of prosperity and depression only a few weeks ago. He remarked that it is hardly conceivable that the modern business world should endure the recurrence of those commercial cataclysms in which factories close for lack of a market while idle workers suffer want, although the very productive capacity that is laid idle could supply all wants. It is well that we should think of this in a time of plenty, and that business leaders and legislators should concern themselves with the problem. Though its agencies are obscure, thorough study should succeed in showing the way toward a solution.

What scientific method may do in the matter was suggested in a remarkable address by a physicist, Ostwald, some years back. He pointed out that supply, responding to demand, is bound to lag behind demand just as the current set up in an electric coil lags behind its electromotive force; and since the growth of supply tends to check demand, with an action quite like that in the coil, a wavelike alternation tends to result. He pointed out also that the economic disturbance is due mainly to the phase displacement—to the time-lag of supply. It takes time

for supply to learn of demand and meet it, and then it is apt to overshoot its mark. Finally, he suggested that this phase lag may be lessened by more accurate and prompt knowledge of facts. Ostwald was speaking in advocacy of science and research. With slight extension, his reasoning may prove profoundly significant to practical ends.

Technical and scientific research is of unquestioned importance in economic advancement. Industries have languished and decayed for want of it. Moreover, such a notable phenomenon as the continuous rise of the automobile industry may be credited in part to maintained study, leading to improvement ahead of demand. But a study of at least equal importance is economic research. In much of our industrial structure the disastrous lag, the rocking of the economic boat, may be overcome by study of economic facts and movements that will enable production to keep close pace with demand. To put it simply: If the year's needs can be forecast and charted in advance with reasonable certainty, production may be geared to demand without either lag or over-development. This result achieved, there need be no more swings from seller's market to buyer's market, from overtime to idleness.

Industrial analysis of such scope and importance is yet barely in the making. Its future development will call for a co-operation of government and industry beyond anything yet achieved. But once the subject is given intensive study, the vital importance of such analysis will be seen and its full establishment will be brought nearer. Senator Jones' action in seeking legislation offers a welcome opportunity for such study.

The bill itself is curative rather than preventive, since it deals with unemployment—an effect rather than a cause. Its plan is to stabilize employment by using public-works construction as a reservoir to balance the variations of private demand. Basically the plan is ideal, to the extent that public works are able to take up this slack in employment. Its difficulties are those of applying it in practice.

Direct application would appear possible only under a benevolent despotism, while modern government requires special machinery. The machinery provided in the bill is the appropriation during each prosperous year of $150,000,000 above current needs for federal enterprises such as roads, buildings and river and harbor work, this excess to be accumulated in a reserve fund. Whenever during a three months' period private construction work throughout the country falls 20 per cent below the corresponding average for 1926 and 1927, this reserve is to be put to use by the President in increased public-works construction.

One need not study far to perceive serious difficulties in such procedure under our present-day systems of governmental economics and politics. To indicate but two: The hazard of amassing and maintaining such a fund against the persistent and rapidly growing pressure of local demand for government works represents a vital threat against its feasibility. Again, the necessity of holding needed works on a reserve list during half a dozen prosperous years in order that they may be undertaken when a depression comes represents an equally serious objection. It will always be vital to good public business that only worth-while works shall be built; but will this be possible when the demand comes that the government undertake large-scale construction in order to furnish employment? To waste public funds in useless or unremunerative construction cannot cure any evil, but rather will bring new evils into being.

But we speak of practical difficulties surrounding the proposal only with a view to fullest possible discussion of the remarkable subject in its entirety. We believe that progress toward stabilizing employment is possible, and, still more, that industrial stabilization on a broad basis can be approximated if we will but study the subject thoroughly and then have courage to use the powerful machinery at our command. Already one of the most difficult elements of the problem, financial credit, has been admirably stabilized. To bring production and the employment of labor under the sway of similar stabilization appears well within the range of the possible.

Municipal Bonding by Fiat

STUNG by a sweeping defeat in a referendum vote on a $30,000,000 bond issue for public improvements, the city fathers of Montreal declared that the non-voters were really in favor of the loan or if not should be penalized for not voting by being counted as voting in the affirmative. To put this novel theory into practice the Quebec Legislature is to be asked to pass a bill to that effect. Both the diagnosis and the cure seem to be wrong.

Faith of the Montreal electorate in its city council might well be shaken by the inaction and attempted deceit of the body during last year's typhoid epidemic and by its haste and secrecy a year ago in voting, without public notice and even without notice to many of its members prior to the meeting, to buy the property of the Montreal Water & Power for $5,000,000 in excess of what had been paid for it at a private sale a few months earlier.

The bond defeat already mentioned is the more significant because it was in a double sense a taxpayers' vote. Only taxpayers could vote; both ballots and the valuation of the property on which they paid taxes were counted. On both scores the bonds were defeated. As stated in our issue of Feb. 23, p. 295, all things indicate that those much interested in supporting or defeating the bonds voted, and with discretion, but for every one who cast a ballot there were two with the necessary property qualification who did not.

It is a far cry between the Montreal proposal to count all non-voters in favor of a bond issue and the statutory or charter requirements that rule in some cities where more than a mere plurality of popular votes is required to authorize a bond issue—sometimes at least a two-thirds majority of all ballots cast. Fears that a small minority of the entire voting population might impose debt obligations on a city in an off year have sometimes gone so far in the past as to require that affirmative votes must be a certain percentage of all the votes cast at a major election. This provision, for example, repeatedly killed much needed water-works and other improvements in Atlanta, Ga., until finally state legislation to remove or lower the bar was obtained.

Wrong in diagnosis and remedy as we believe the Montreal plan to be, if the people of Montreal and also the provincial legislature and courts of Quebec will stand for it, the rest of the world, rather than protest, should welcome a test of so novel a plan—trebly novel because under it only taxpayers vote, but both their ballots and the amount of their taxed wealth count, while in addition all non-voters and their property are added to the affirmative votes of those who cast ballots.

West Side Sewage-Works Construction at Chicago

Remarkable Use of Conveyors With Central Control for Mixing and Placing Concrete—Baffle Walls of Precast Slabs Hasten Imhoff Tank Construction

CONFRONTED BY DRASTIC LIMITATIONS on the withdrawal of water from Lake Michigan to dilute sewage, the Sanitary District of Chicago is prosecuting work on a group of sewage-treatment plants which are notable even in this era of stupendous metropolitan sewage-works. The West Side sewage works is the largest of the group. Combined with its size there was the necessity of exceedingly rapid construction. To meet the demand for performing a large volume of work in a short time mechanical equipment and construction inventiveness have been called into service to an unusual degree. Distinctly new construction methods and plant arrangements have been adopted, which emphasize the West Side sewage-works operations as an advance in construction engineering which merits careful notice and appraisal as an example for the future. —EDITOR.

THE short contract period of eighteen months for the West Side sewage-works of the Sanitary District of Chicago (300,000 cu.yd. of excavation and 115,000 cu.yd. of concrete) required, in planning their construction, concentration on plant equipment and arrangement. Methods and equipment that are unusual in sewage-works construction have been devised to save time. Belt conveyors are employed in a notable way to handle both concrete materials and mixed concrete. The material-handling and concrete-mixing equipment is coordinated to an exceptional degree for central control and automatic operation. Precast concrete slabs, used in place of poured-in-forms or gunite baffle walls, are expediting Imhoff tank construction. Special concrete pile placement methods eliminate hazardous friction of settling fill on piles penetrating to stable ground underneath the fill. Plant layout provides for the possibility of having to service additional operations as successive sewage-works units are added. All these devices are pointed toward reducing construction time.

Time is the essence of this construction operation in a very vital way. In the general plan of sewage-works development for the Sanitary District of Chicago the excess sludge from the North Side works (to be put in operation about April 1, 1928) is to be pumped to and given final digestion in Battery A of the Imhoff tanks of the West Side works. Delay in their completion, then, involves real damages, for by July 1, 1928, outlet has to be had for the North Side sludge.

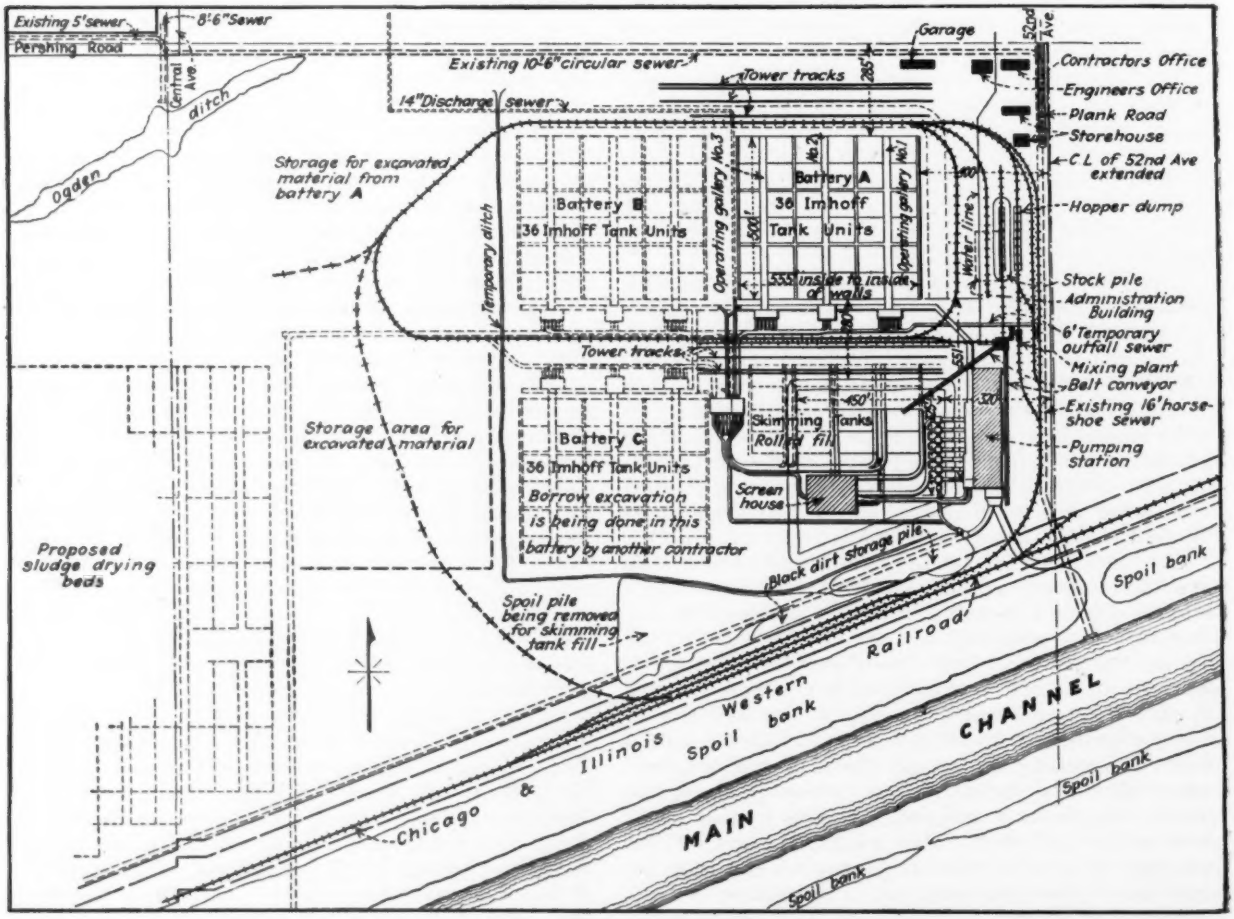


FIG. 1—PLAN OF WEST SIDE SEWAGE-WORKS, SHOWING CONSTRUCTION PLANT LAYOUT

The structures and construction of the North Side sewage-works were described in *Engineering News-Record*, March 11, 1926, p. 394. An article outlining the entire sewage-works plan was published in the preceding issue, March 4, 1926, p. 363. In the brief description of the West Side works in the earlier article, their function in the complete system was explained. Here only the main structures are described in only enough detail to indicate the construction task.

Sewage-Works Structures—The West Side sewage-works are being built to treat the flow from about 100 square miles, generally the area north of the Chicago River and main drainage channel and south of Fullerton Ave., but also including the "loop" district south of the concentration of concrete yardage and heavy machinery. Third, there is the group of units embracing the skimming tanks, grit chambers and coarse screens, meter vault, conduits and sludge-drying beds.

There are 108 Imhoff tanks in three batteries of 36 tanks, each 80x80 ft., with 33 ft. maximum water depth. One battery is under construction. It contains 66,000 cu.yd. of concrete, with an average reinforcing steel content of 120 lb. per cubic yard. The concrete spread is about 2 cu.yd. per square yard. In the operating galleries and tanks and in the valve and ejector houses there are about 1,250 tons of castings—pipes and specials. From the operating viewpoint the tanks are designed on the basis of a detention period in the settling compart-

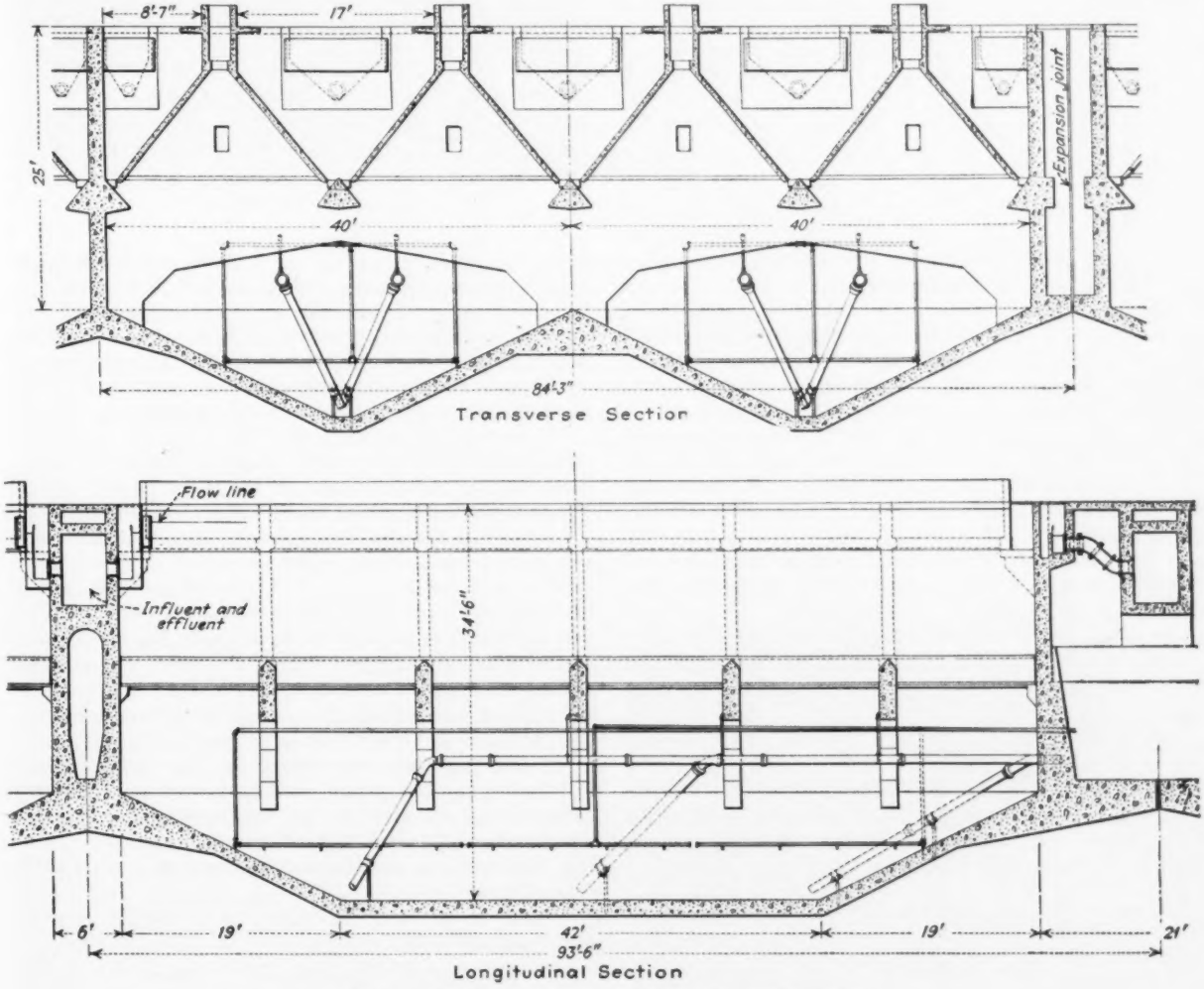


FIG. 2—SECTIONS OF IMHOFF TANK STRUCTURE

river. Fig. 1 shows the location and general plan of the several units. The whole plant is designed for a population of 1,850,000 and an average flow of 400 m.g.d. In addition the sludge from a population of 1,013,000 at the North Side works will be digested and dried at this plant. These populations are expected in 1940.

Considering the main structures, which contribute the great volume of earth-moving and concrete construction, the outstanding units are the three batteries of Imhoff tanks. Then comes the pumping station, with its high

ment of two hours at average flow and a sludge digestion capacity of 2 cu.ft. per capita for the tributary West Side population and 5 cu.ft. per capita for the excess sludge from the North Side.

In the group of units comprising the skimming tanks, grit chambers, etc., there are 30,500 cu.yd. of concrete and 3,700,000 lb. of reinforcing steel. The castings, pipes, specials and miscellaneous iron amount to about 775 tons. Briefly, the eight skimming tanks, four of which are now under construction, are each 105x66 ft., with a water depth of 11 ft. They provide for a deten-

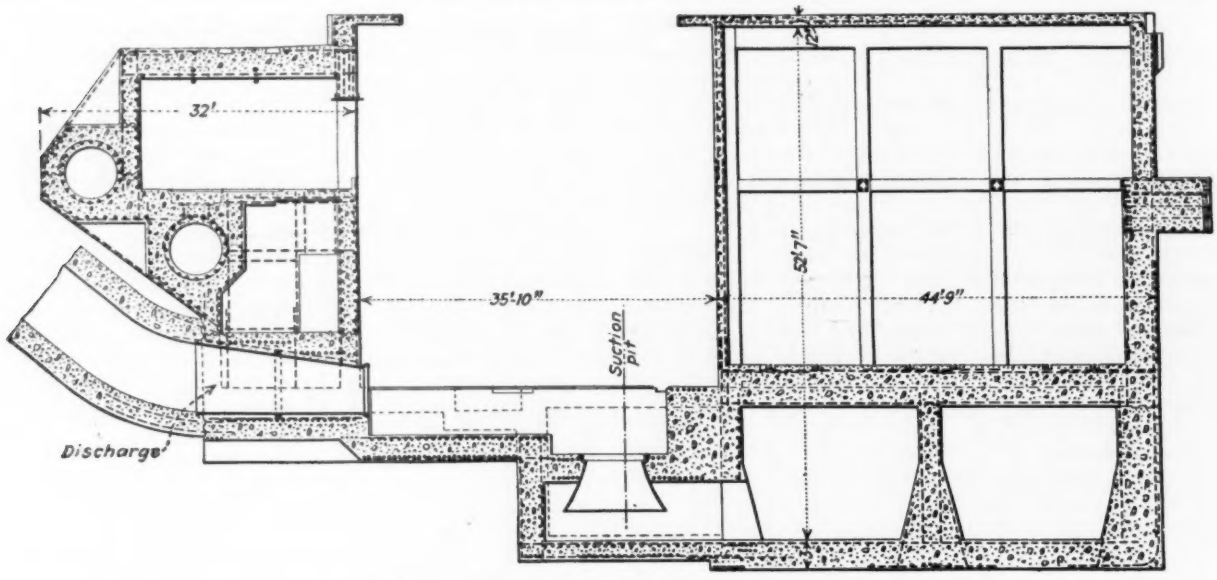


FIG. 3—CROSS-SECTION OF PUMPING STATION

tion period of fifteen minutes. The four grit chambers are 90x8 ft., with a flow depth of 5.6 ft.

The main pumping station is a brick, stone and steel structure, 82x369 ft., the substructure of which, including scum chamber, approach channel and about 500 ft. of adjacent sections of 8-ft. and 17½-ft. intercepting sewer, contains 19,000 cu.yd. of concrete, which gives a spread of 3½ cu.yd. per square yard. In the substructure there are 1,750,000 lb. of reinforcing steel and 175 tons of piping, specials and other metal work. The main sewage pumps are two 100-sec.-ft. units, with 48-in. suction, 36-in. discharge and 1,000-hp. motors; and five 200-sec.-ft. units, with 54-in. suction, 48-in. discharge and 2,000-hp. motors. The pumps operate against a total dynamic head of 68 ft. The secondary equipment is four 30-sec.-ft., 24-in. centrifugal pumps for returning sewage from the grit chambers to the influent conduits to the Imhoff tanks, with 75-hp. motors, and the electrical substitution units and air-compressor units, with an aggregate capacity of 6,250 cu.ft. of free air per minute and compressing to 40 lb.

The sections, Figs. 2 and 3, indicate the type of concrete construction, generally wall and slab work much cut up but mostly of fairly heavy sections. The yardage spread is wide and also in places the yardage concentrations are great. Notably the tonnage of metal placement—reinforcing steel, pipes, specials and fittings—is large and many of the units are heavy. The machinery units are exceptionally heavy. These volumes, weights and variety of materials, coupled with the wide area of their placement, made equipment for handling and carriage the controlling problem in plant planning.

Access and Plant Planning—The site of the West Side sewage-works is almost level prairie. The south boundary is the right-of-way of the Chicago & Illinois Western Railroad, which borders the north right-of-way line of the main drainage channel, across which there are no near-by bridges. The extension of South 52nd Ave. is the east boundary. This street and the railway are the available means of access to the work. With the quantities and loads to be brought in, the railway naturally was the selected means; the street, extended by a plank road, served as a stand-by and for minor haulage. Job railway development was, then, the first construction task, and it was worked out as shown by Fig. 1.

In planning the plant layout for the first contract, one battery of the Imhoff tanks, the possibility of the early future construction of the remaining units for which the plant might be used was an important factor. For the work under immediate construction—Imhoff

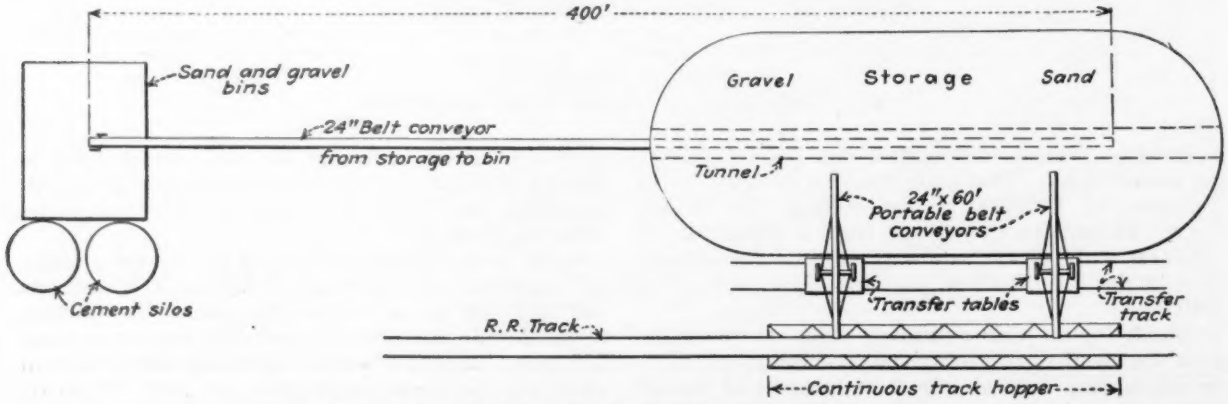


FIG. 4—DIAGRAM OF AGGREGATES UNLOADING PLANT

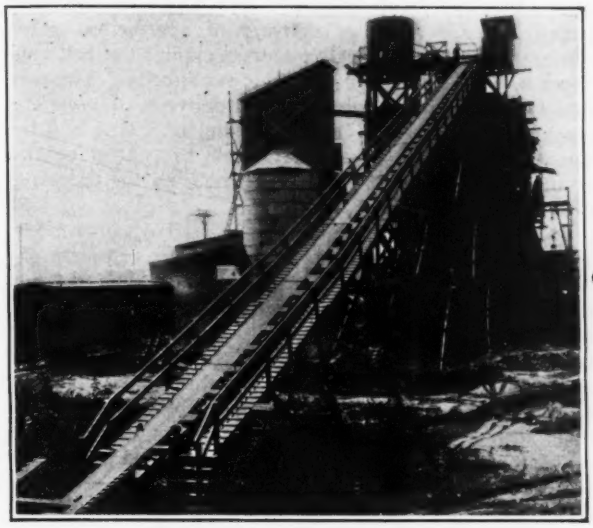


FIG. 5—BELT CONVEYOR FROM STOCKPILES TO MIXING PLANT

tank battery A, pumping station and the skimming tank unit—the logical location for the concrete materials and mixing plant was the area east of the structures to be built and along South 52nd Ave. This was the nearest available area to the center of gravity of concrete placing. It was also the area most convenient of access by South 52nd Ave. It fitted excellently into a loop railway service of the whole job, including excavation and spoil disposal, and it was not badly situated to serve future work on batteries B and C of the Imhoff tanks. Indeed, looking at Fig. 1, it is noticeable how little track extension and equipment shifting are essential to extend the plant plan for the present part of the work into a plan for all the work.

Specifically the plant elements are: (1) Plant for excavation and filling, (2) concrete mixing and placing plant and (3) a job railway system serving all plant units.

Earth-Moving Plant and Methods—There is in the operations under contract about 300,000 cu.yd. of excavation, of which about 130,000 goes into rolled embankment for the skimming tanks and grit chambers and the remainder into various spoil banks to be used later in filling around the various structures. Part of this excavation was from the foundations for structures and part from a borrow pit. The material was virtually all clay, some of it quite hard and some containing vegetable matter. It was good standing ground when dry, but was soft when wet. There was virtually no water except surface runoff. Machine excavation was not difficult in any place.

Summarized briefly, the pumping station emplacement called for a pit 150x425 ft. and 54 ft. deep aggregating 80,000 cu.yd. The Imhoff tank excavation was 515x575 ft. and aggregated 150,000 cu.yd. The fill for the grit chambers, coarse screens and skimming tank unit amounted to 130,000 cu.yd., made up from the pumping station excavation and from borrow.

The excavating and filling methods were ordinary. Dragline excavators made the main cuts. At the Imhoff tank emplacement one machine with a 70-ft. boom and a 2-yd. bucket loaded into trains of 12-yd. dump cars which took the spoil to the storage space shown by Fig. 1, whence ultimately it will be recovered and used for backfilling and grading around the structures. A flat-bottomed cut over the whole tank area was first made to about the elevation of the tops of the hopper bottoms. Then the hopper bottom cuts, 40x80 ft., were shaped out, keeping just ahead of the bottom concreting so that the cuts would not be lost because of rain before the 3-in. sub-bottom of 1:3:6 concrete was in place to hold them. The feature of chief interest is that these hopper-shaped cuts were made by dragline so accurately that the amount of finishing by hand was almost negligible.

In the pumping station cut, depth was about the only complication to straightforward dragline work. Two draglines, an 80-ft. boom, 2½-yd. bucket steam machine and a 45-ft. boom, 1½-yd. bucket gasoline machine, were used, both traveling on the surface lengthwise of the pit. Both loaded direct into 5-yd. trailers hauled by 10-ton caterpillar tractors to the rolled fill for the skimming tanks. Five tractors and eight trailers did the work, one tractor being used on the fill to bulldoze the dumped spoil flat for rolling. This was done also for the team-hauled borrow, excavated from Imhoff tank battery C by elevating graders and later by a power shovel, and the borrow excavated from the old spoilbank by a 1¼-yd. power shovel. The fill as placed was rolled by a 10-ton roller. A notable concrete pile foundation through this fill is described in a succeeding paragraph.

Concreting Plant Design—Broadly, there were two areas of concrete placement. One comprised the screen house, skimming tanks, pumping station and their conduits and appurtenances, and the other comprised the Imhoff tanks and appurtenances. The dimensions of the two areas are not greatly different and the yardage of concrete to be placed in each is about the same. With the general location of the concreting plant determined as described, the location of the mixing plant was logically on the middle line between the two concreting

FIG. 6—BELT CONVEYORS DISTRIBUTING CONCRETE TO PUMPING STATION

areas, as shown by Fig. 1. This location gave about the minimum yardage radius of haul, considering both receipt of materials from stockpile and delivery of concrete to structure. This location also fitted nicely the possibility that the same plant might be used for concreting the remaining two batteries of Imhoff tanks.

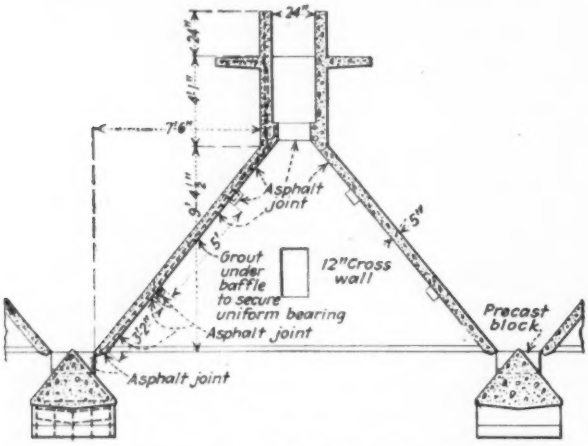


FIG. 7—PRECAST SLAB BAFFLE WALLS FOR IMHOFF TANKS

By scheduling the concreting of the skimming tank-screen house units to follow the bulk of the concreting on the pumping station, the areas of simultaneous operations were cut down considerably. Thus a main belt carrier for concrete feeding to portable radial belt distributors met the conditions very well, and form and reinforcement handling was within the range of traveling cranes. Belt handling of concrete was adopted, then, for its flexibility in placing concrete and its continuous gradual delivery of concrete into slab wall sections heavily reinforced. For delivery of aggregates to the mixing plant from tunnels under stockpiles the belt conveyor had an established economic superiority. The two, belt receipt of materials and belt delivery of concrete, completed a system of carriage of uniform type and the same technique of operation capable of central control from the mixer tower top, from which all the construction area was visible.

In the tank construction wide spread of operations, concreting in stages and repetitive sequence of operations required a more versatile handling device than the belt conveyor, and a cableway was adopted, with railway lines to serve it with materials. Ultimately the cableways had to be supplemented by two traveling cranes operating on 24-in. I-beam bridges on top of the walls when the work reached the construction stage which permitted their installation, but in general railway delivery and cableway handling were the tank construction procedure.

Receiving and Handling Concrete Materials—The concrete material plant was planned to receive and unload daily 40 carloads of sand and gravel. The general design, as shown by Fig. 4, is the familiar one of stockpiling over a tunnel and dropping the material through roof gates to a belt conveyor leading to the mixer bins. There are, however, two unusual features—the central control from the mixer tower of the electrically operated roof gates, and the car-unloading plant. The cars dump into a track hopper, as shown by Fig. 4, from which two portable inclined 60-ft. belt conveyors deliver to the stockpiles. The novel feature is the mounting of each conveyor on a transfer table running on a transfer track between and parallel to the track hopper and the stockpile tunnel. The tables have mobility along the stockpile and the conveyors can be moved on their own wheels back and forth across the tables.

FIG. 8—CASTING YARD FOR BAFFLE-WALL SLABS

The aggregate conveyor to the mixer bins is shown in Fig. 5. Bulk cement is used and is delivered in 50-ton carload lots by the same track that brings in the aggregate. The cars are unloaded by the usual power scraper into the boot of a bucket conveyor rising between the two cement silos and chuting right or left into either. In general the arrangement so far is conventional, but at the mixer plant there is automatic carriage and control of cement that is unusual.

Mixing Plant Procedure—A four-story tower carries the mixing plant. On the roof are the water tank, belt discharges and control house. Below are a sand bin and a gravel bin, each with a three-hopper bottom, one for each 1-cu.yd. mixer. In each stone bin hopper is a batcher and in each sand bin hopper is an inundator com-

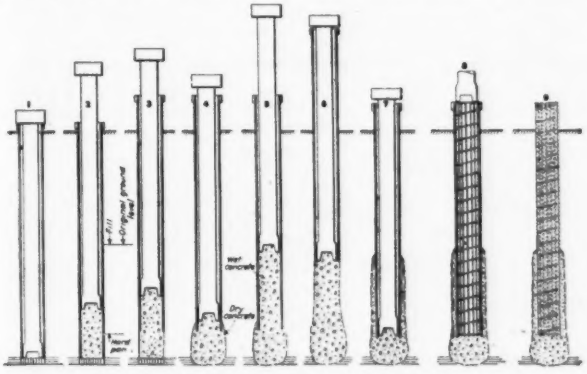


FIG. 9—CONCRETE PILE CONSTRUCTION PROCESS IN ROLLED FILL

ing in the third story, devoted to proportioning. The mixers on the second floor discharge into a hopper overhanging the ground tracks. In general, the arrangement is quite ordinary except for the cement handling.

The cement silos, filled from the cars as described, hold five carloads each. They have hopper bottoms feeding to a screw conveyor, which feeds to the boot of a between-silos bucket elevator rising to fourth-story level, on which are the aggregate bins. Here is a ½-car cement bin, which receives the bucket elevator discharge by a screw conveyor. From the bottom of this bin a screw conveyor runs to a 700-lb. scale hopper over the cement scales on the proportioning (third) floor. The scale hopper gates into a measuring box on the scales and from this box a screw conveyor runs over the three mixer-charging hoppers with a gate to each.

From the scale hopper the operation is virtually automatic. A push of a button and the screw conveyor from the scale hopper begins to feed to the measuring box. When this has its batch, the tip of the scales beam shuts off the flow. A pull of a lever discharges the measuring box into the screw conveyor, which leads over the mixer-charging hoppers, and by opening the proper gate the cement goes to the mixer that awaits it. A man for cement, one for each stone batcher and one for each inundator, seven men, do all the proportioning for three mixers. A man on this floor also controls the operation of the mixers.

Concrete Control and Distribution—For cableway distribution to the Imhoff tanks, the concrete is carried in 7-yd. bottom-dump buckets, one at a time on flat cars hauled by steam locomotives, to the cableway. The arrangement is wholly conventional.

Belt distribution to the pumping station substructure and later to the skimming tanks is more unusual. Indeed here is perhaps the most purposefully planned and the largest outfit for conveying mixed concrete by belts of which American construction furnishes an example. The general set-up is shown by Fig. 6. For the pumping station, a 500-ft. belt conveyor runs along the pit edge and delivers to a mobile cross-conveyor reaching out over the pit. The hoppers below the mixers feed into this belt; it is 24 in. wide and travels 380 ft. a minute. The noteworthy feature of the lateral conveyor is that it travels on a track parallel to the main conveyor, so that with the movable tripper it can take concrete from any point along the main belt. It delivers to chutes going to the forms. By keeping the flow from the mixer hoppers constant, segregation gives no trouble.

The skimming tanks, grit chambers, meter house, valve and ejector houses and miscellaneous conduits, being built under the third contract, require a somewhat more elaborate scheme of concrete carrying. As will be seen from the general layout, these are widely scattered over a considerable area. The skimming tanks, grit chambers and other structures built on the rolled embankment are supplied by the belt conveyor remodeled to fit conditions here. As used, it is about 300 ft. long, carried on wooden trestles to the northeast corner of the rolled embankment at a 1:7 slope. Then the belt discharges into a 2-cu.yd. receiving hopper, from which the concrete is carried to the point of placement by three-wheeled 1-yd. dump tractors. When it is necessary to elevate the concrete into wall forms or to carry it out into trenches, this is done by portable belt conveyors. This makes a most elastic method of conveying and placing concrete, which is giving exceptionally good results.

Concrete for the meter house substructure and the adjacent approach channels from the main influent conduit is conveyed from the mixing plant in 2½-yd. steel dump buckets on a flat car drawn by a steam locomotive, and is handled into the forms by one of the large draglines operating as a crane. The valve and ejector houses, service tunnel and conduits adjacent to the Imhoff tank battery are served by the cableway.

Three mixtures of concrete are used, 1:3:6 for filling and sub-base, 1:2:4 for the bulk of the work and 1:2:3½ for baffles and other thin walls and slabs. A graded aggregate is required and the water volume is kept between 0.8 and 1 cu.ft. per cubic foot of cement, varying with the moisture content of the aggregates. In general there is observance of water-cement ratio limits, but the thought is primarily to get concrete that will get into narrow forms and compactly around close reinforcement and show no honeycomb, and if this requires modifications in the water-cement relation, they are employed.

Concreting and Form Work—There is nothing out of the ordinary in placing concrete or in form construction. Unit forms are employed on the tank work as freely as practicable, and these are handled by the cableway and by a crawler crane traveling on a bridge spanning the tank side-walls. The use of this crane is unique for the purpose.

Precast Slabs and Concrete Piles—The outstanding construction novelty of the Imhoff tank works is that the baffle walls are built of precast slabs instead of being poured between forms or being built up by guniting upon an underform. Fig. 7 shows the construction adopted and Fig. 8 shows the casting yard operations. The 12½x 13-ft. slabs, 5 in. thick, weighing 5 tons, are cast in tiers

with building-paper separators. A considerable gain in speed has been obtained by this method of baffle construction, and as every slab is pretested by lifting and placing, it is expected that sound structure will be assured.

Another exceptional construction is the pile foundations for the skimming tanks. These, as already noted, are set on a rolled fill, and natural settlement of this fill could not be waited for if the work was to be completed within the time limits set by the contract. To insure a stable tank foundation, concrete piles through the fill and into the natural soil below were adopted. In planning the pile loads it was sought to eliminate the down-drag on the pile sides by the settling fill. Fig. 9 shows the method of construction adopted by the Western Foundation Company, Chicago, Ill., the sub-contractor for the pile work. The friction length of pile is in the natural ground; above, in the fill, the metal casing keeps friction down.

Direction—The work is being done under contract for the Sanitary District of Chicago, of which Edward J. Kelly is chief engineer, Philip Harrington is assistant chief engineer and L. B. Barker is resident engineer. The general contractor is the T. J. Forschner Contracting Company, L. B. Fugitt, superintendent of Imhoff tank construction, and R. H. Burke, chief engineer and superintendent of construction at the pumping station and skimming tanks.

Alteration of a Steel-Frame Building With Use of Welding

Beams Carrying Increased Load Were Reinforced by Cover Plates Welded On With Edge Beads

By Grayson Gill

Structural Engineer, Herbert M. Greene Company, Architects, Dallas, Tex.

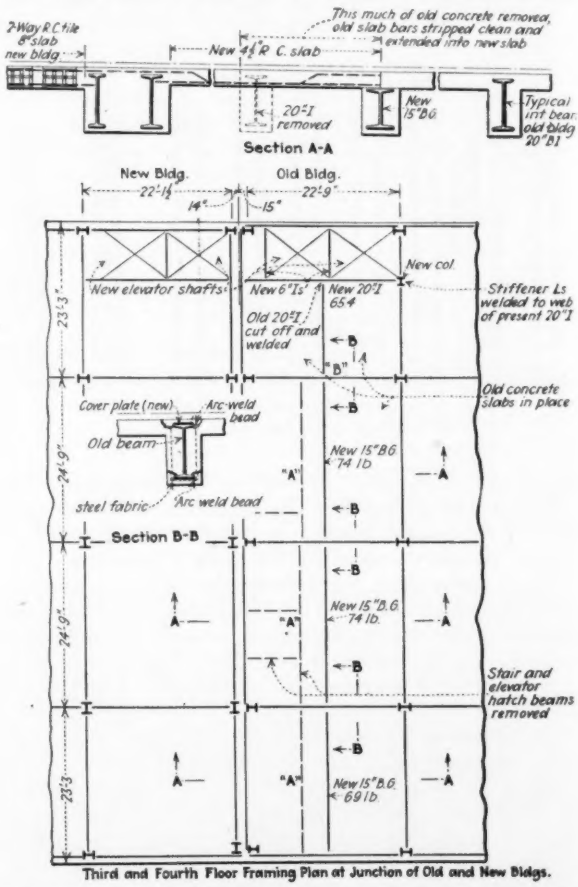
In THE discussion of structural welding at the American Welding Society meeting in Detroit last fall, Joseph Matte stated that welding will be found preferable to riveting in all cases where it offers some inherent advantage that is of value in the particular application proposed. A case such as this occurred in the recent remodeling of the Neiman-Marcus Building, in Dallas, Tex.

The original building, four stories and basement, 96x100 ft., was enlarged by another unit of the same size on the south, extending the structure through one city block from Main St. to Commerce St., with a 200-ft. frontage on Ervay St. The elevators and stairs in the old building were in the south bay, and the improvement required moving these to the west bay of the new and old buildings as shown in the illustration.

The steel framing in the panels originally containing the elevators and stairs was not heavy enough to carry the new dead and live loads resulting from flooring over these hatches, though the column sections were ample, the columns having been designed for an eight-story building and the south wall having been entirely removed. It was also required that the intermediate beams *A* be in the center of the panel to match the ceiling plan of adjoining panels of the old building.

Removal of the steel beams *B* and the substitution of heavier sections would have been a costly operation and would have resulted in serious inconvenience and loss to the occupants, since business was being carried on during the remodeling work. Arc-welding was therefore utilized to reinforce the beams, and it proved satisfactory in every respect.

The old elevator hatch beams *A* were removed, and new 15-in. Bethlehem girder beams were placed in the center of the panel under the old concrete slab, the bottom of this new steel coming flush with the bottoms of the old 20-in. I's in the typical panels. The old slab was then cut off along the center line of these new beams, and a new slab cast between these beams and the old spandrel beams. Beams *B* were reinforced, as shown, by welding cover plates to top and bottom flanges. Dur-



FRAMING PLAN AND BEAM SECTIONS, NEIMAN-MARCUS BUILDING, DALLAS

ing the reinforcing of these beams they were shored up, the shores serving both to take the dead-load strain off the beams and to hold the cover plates securely in contact with the flanges of the I-beams. The width of the cover plates, 7 in., was such as to permit a full welding bead to run on both sides of the plate.

The general contract was executed by the Watson Company, of Dallas, and the welding work was done by the Mosher Steel & Machinery Company, of Dallas, subcontractors for the structural steel. The writer is indebted to W. M. Eliot, chief engineer of the latter company, for suggestions in connection with the details of this work. The Herbert M. Greene Company, of Dallas, was architect.

Wind-Braced High Buildings in the Florida Hurricane

The following is the final report, slightly condensed, of a special committee of the Structural Division, American Society of Civil Engineers. —EDITOR.

IT WOULD be of considerable value to the engineering profession if an accurate determination of the wind pressure to which buildings were subjected in the Florida hurricane of Sept. 17 and 18, 1926, could be made, but your committee does not deem it possible. On the top of the Meyer-Kiser Building was a small observation room about 18x21 ft., with four small columns in the corners supporting the roof. The walls were blown out and the four columns were bent. It would require about 65 lb. pressure to produce the distortion that occurred, and this figure is probably as good as can be determined but cannot be taken too seriously, as the area of exposure at the time of failure is uncertain.

Professor Morris, of this committee, has computed that it would require about 60 lb. per sq.ft. wind pressure to bend the columns in the front wall of the Meyer-Kiser Building. It is possible that the failure of the wall allowed the building to sag quickly to leeward and applied a blow of unknown force to the columns, producing a serious effect, though the wind, striking the building at an acute angle, may not have applied a very severe normal pressure. Hence the static stresses computed may have little relation to the applied pressure. The evidence, however, indicates that for moderate-sized areas the storm probably exerted a pressure of more than 50 lb. per sq.ft., but there is no evidence that this was the case over the entire area of a building.

The two Miami buildings that suffered most from the storm were the Meyer-Kiser Building and the Realty Board Building. A study of the design of these two buildings teaches some interesting lessons.

Fig. 1 shows the plan of the Meyer-Kiser Building. Based on the number and size of rivets in the wind braces, and assuming the elastic limit of the steel at 36,000 lb. per sq.in., the steelwork alone without any help from the walls should have resisted a wind pressure of about 15 lb. per sq.ft. at the fifth floor. However, the clip angles were so thin that in bending they did not develop more than 25 per cent of the value of the rivets. These clip angles in many cases bent or broke, thus destroying all necessary strength, and even if they had not broken they would have been so limber as to give the building little stiffness. The columns, too, were not suited to develop the strength for the type of the connections used.

The columns were made up of plate-and-angle sections and in the area that failed had few cover plates. The thickness of the angles in the columns was such that the outer rivets connecting the clips to the columns were not thick enough to develop the full strength of the rivets without bending the flange angles of the columns. In addition to this in the south end of the building the floor system was broken up with elevator shafts and there was very little bracing in the floor system, and this was on beams shallower than the 24-in. spandrel girders in the front or south wall. The result was that the front or south wall took nearly all the wind load for this end of the building till it failed. At the north end there was bracing of a similar character, but more bracing in the floor system, which evidently is the reason for less distortion of this end of the building.

It is evident that there was no adequate wind bracing in this building, and the bracing that was used was rendered valueless by the details. It is difficult to under-

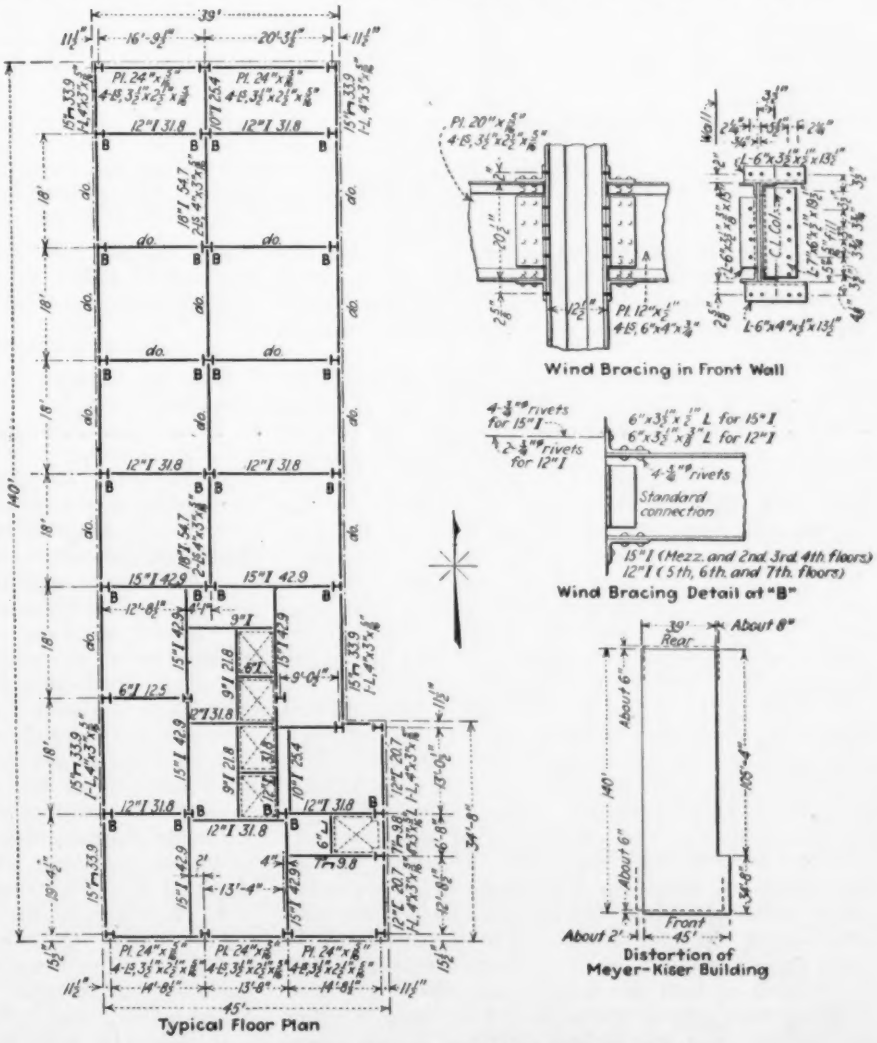


FIG. 1—FLOOR PLAN AND PRINCIPAL WIND-BRACING DETAILS OF MEYER-KISER BUILDING

stand how any loans or hurricane insurance could have been obtained on this structure. The results bring out forcibly the desirability of engineering advice for financial organizations as well as for the owners.

Damage to Realty Board Building

The Realty Board Building also suffered quite severely during the storm. The walls and partitions were badly cracked, but the steel framework was not badly distorted. E. A. Stuhrman, who was engineer in charge of reconditioning this building, states that a careful survey shows that it was only $3\frac{7}{8}$ in. out of plumb, and part of this

The Daily News Building has a tower 40 ft. square and about 255 ft. high. This building was figured to resist a wind pressure of 20 lb. per sq.ft. in either direction at a unit stress of 24,000 lb. per sq.ft. in the steelwork. In the design of the wind bracing, care was used in proportioning the details as well as the main members. There was a special effort to make the connections stiff as well as strong. Besides this, heavy interlocking tiles were used for the walls instead of partition tiles. This building suffered no structural damage. Based on the above, this building should not show signs of failure before the elastic limit of the steel was reached, which is

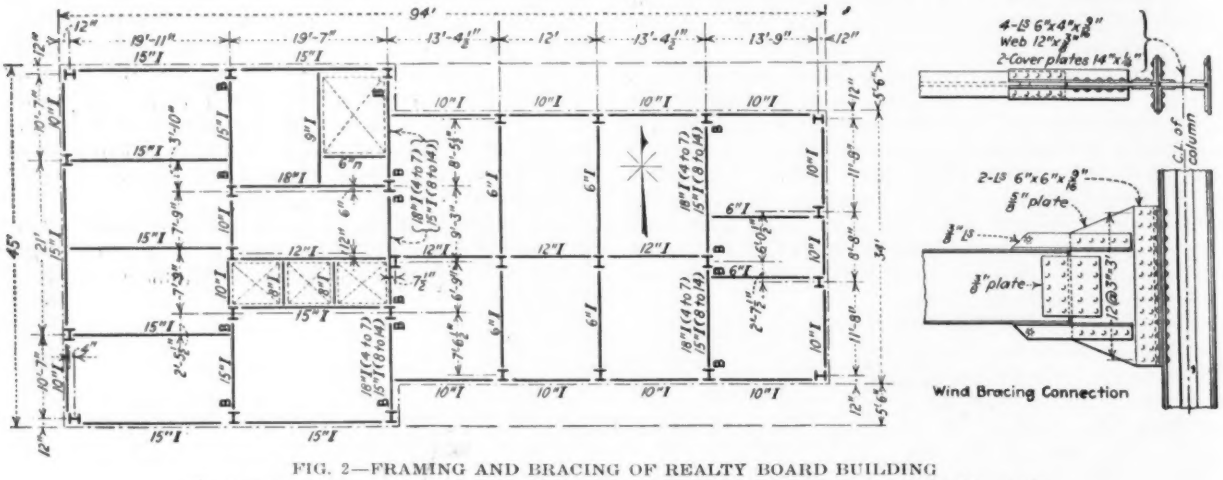


FIG. 2—FRAMING AND BRACING OF REALTY BOARD BUILDING
Front or west face of building is at left in the plan. Column 14 is on the north side at the court offset, and column 15 is directly south of it.

may be due to inaccuracies of erection. There was greater evidence of lack of stiffness than there was of lack of strength, as the structure swayed enough to crack the walls, without seemingly passing the elastic limit of the steel.

This building was fifteen stories high and the height of the top of the pent house was about 166 ft. above ground. The main bracing connections were all attached to 15-in. and 18-in. beams. The other transverse beams were 6 in. and 10 in. deep in the typical floors, with very much less rigid connections. It is probable that the former took practically all the wind stresses. The connection of the wind brackets to the columns is an important feature of the construction. The outer lines of rivets connecting the brackets to the columns were practically useless, as the connection angles of the thickness used would be weak in bending at the root if the full strength of the rivets used were developed.

A study of the design indicates that a genuine effort was made to brace this building properly, and any shortcomings should not be attributed to an attempt at false economy. The following points, however, should have been given more attention: (1) The two unbraced panels in the rear were an element of weakness; (2) the front and rear walls should have had stiffer bracing, as a fairly stiff steel frame is necessary to prevent cracking of walls; and (3) special provision should have been made at the stair opening near column 14 to prevent the beam between columns 14 and 15 from bending laterally. In addition, in both this building and the Meyer-Kiser Building some attempt should have been made to stiffen the building in a longitudinal direction, as this would have had a strong tendency to resist torsional racking.

about 36,000 lb. per sq.in. This is equivalent to a wind pressure of 30 lb. per sq.ft over the entire surface without any assistance from walls.

Conclusions as to Wind Bracing

The main lessons to be learned from the foregoing considerations are:

1. Adequate wind bracing is necessary in the construction of a building.

2. The details must be carefully designed for the same strength as that used in design of main members.

3. In designing different types of wind braces for one floor level the designer should take the relative stiffness of the members into account and not depend too much on the arithmetical summation of the total strength of the connections, as some members may be greatly overstressed before the others take any large proportion of the stress. In buildings of moderate size, however, it is permissible to take care of this point by the use of an adequate unit wind pressure.

4. Stiffness as well as strength is a prime requisite for good steel design. This is especially realized by our best engineers in designing narrow and high buildings used for living quarters, such as hotels and apartment houses, where the confidence of tenants in the stability of the structure is of the utmost importance.

5. The effects of the Florida hurricane indicated that the floor system acted as a stiff plate or horizontal girder and that all columns were subjected to the same horizontal deflection, but the entire structure twisted where one end of the building was stiffer than the other.

In designing wind bracing this must be given full weight and the bracing arranged, if possible, so that no

twisting action from the wind can come into play. This means that the wind pressure at one end of a building and the bracing designed to resist it must balance the relation between the corresponding pressure and bracing at the other end, so that the structure will deflect about the same amount at both ends. This principle applies especially where one end is higher or narrower than the other.

Wind-Bracing Analysis

The results of the storm showed that for buildings of the size and shape found in Miami the common methods of analysis, as given by Fleming, will produce structures capable of standing up under the most severe conditions. The failures were due to neglect to apply the theory consistently. On the other hand, buildings so designed will not necessarily be sufficiently stiff to give the tenants confidence in their safety. Moreover, in the case of very high or narrow structures the obvious errors involved render the results less secure than is desirable.

From a standpoint of strict theoretical determination of wind stresses, the slope deflection method will probably give the best results. This will be covered by a paper to be published in a short time in the *Proceedings* of the American Society of Civil Engineers by one of the members of the committee, Prof. Clyde T. Morris. Some of the members of the committee, however, are not entirely convinced that Prof. Morris' method can come into universal use on account of the work that it will entail.

One of the members of the committee has used a method apportioning the amount of wind shear taken by the various columns on the basis of the relative moments of inertia of the columns. This is based on the length of the columns being the same. If the lengths between wind brackets vary considerably, as in the case of deep girders, these shears will have to be corrected to take care of the difference in column lengths. A closer approximation would take into account the effect of variations in the stiffness of attached floor beams, which would bring us back to the method developed by Professor Morris.

Wind Stress Measurements—When the American Insurance Union Building, in Columbus, Ohio, was built, due to the initiative of Professor Morris numerous gage points were established on the columns and also targets were located in the elevator shafts by means of which it is possible to measure the lateral displacement of the building during a storm for a height of 34 stories. No doubt a great deal of valuable information could be obtained by careful readings made on this building. Generally owners of buildings are afraid to have any such tests made, as they think it will cause the public to doubt the safety of the building, but in this case, as the matter was all arranged for when the building was constructed and the public understands that the work is for educational purposes, the ordinary objections do not prevail.

Bathing Enjoined to Protect Water

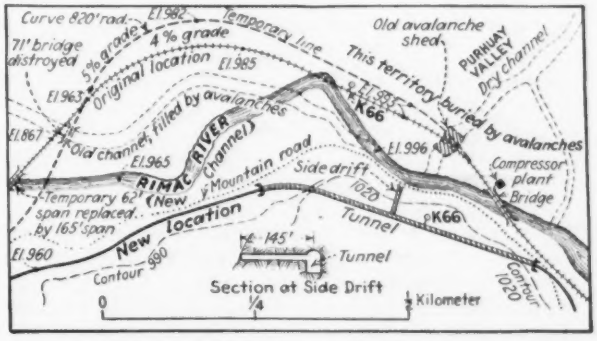
The use of a commercial swimming pool and bath house so located as to pollute a municipal water supply in Texas has been enjoined in accordance with a statutory provision against the pollution of any water being used for drinking and other domestic purposes, the higher court affirming the decision of the trial court. (Texas Court of Civil Appeals: Newton et al. vs. City of Grosebeck, 299 S. W. 518, decided Oct. 6, 1927. Abstracted very briefly in *Public Health Reports*, Feb. 3, 1928.)

Railway in Peru Relocated to Avoid Avalanches

Frequent Destruction Necessitated Difficult Relocation and Rock Tunnel—Labor Trouble Due to Fever

A FEVER-BREEDING DISTRICT was an adverse factor for the engineer in charge of a railway relocation in South America to permit of abandoning a stretch of line troubled by repeated avalanches. It was difficult to keep the necessary skilled labor owing to the somewhat mysterious "verrugas" fever, which attacks all but the natives of the district, who are supposed to be made immune by having the disease in childhood. According to the engineer, it is generally accepted that this disease results from the bite of some blood-sucking insect that flies at night. The fever stage may continue for several months and deaths are frequent.

The line in question is the Central Railway of Peru, a standard-gage line owned by the government and



RELOCATION ON CENTRAL RAILWAY OF PERU

operated by the Peruvian Corporation. It is peculiar in having a continuous ascending grade for nearly 107 miles from sea level at the port of Callao to the summit elevation of 15,806 ft.

When the line was built in the Purhuay district in 1870, it crossed the Rimac River twice, as shown in the accompanying plan. In 1890 an avalanche cut communications for some months. Serious interruptions followed in 1897, 1915 and 1919. With a temporary line on a grade of 8 per cent traffic was restored in four days after this last slide, but fourteen weeks' work with two steam shovels was required to open the old line. In 1920 a reinforced-concrete tunnel or shed was built over the track and successfully carried several small avalanches in 1923 and 1924. Unprecedented avalanches in all parts of Peru occurred in 1925, and on March 19 the Purhuay Valley discharged an enormous avalanche covering the track to a height of 40 ft. at the tunnel and partly destroying the line for a distance of 40 miles. This was noted in *Engineering News-Record* of Oct. 20, 1927, p. 635.

It was then decided to drive a rock tunnel on a relocation, as shown, but as this would require considerable time, a temporary line was built with a grade of 5 per cent and a 62-ft. bridge, so that traffic was restored on May 13. Above the bridge site the river has a 6 per cent grade, so that during flood times its velocity and destructive power are very great. The only available bridge was but a few feet longer than the width of the

river. Pile driving was impossible owing to boulders in the gravel of the river bed, and excavation of any reasonable depth was impracticable on account of the porous nature of the material. It was necessary, therefore, to design special foundations and to build them in the shortest time. The plan adopted was to build a mattress of concrete and old rails. Commencing 24 ft. from the water (that being the length of rails available), excavations were made as deep as possible and were extended gradually as near to the river as the percolation of water would allow. Rails placed longitudinally and transversely were tied together by wire, and concrete was poured over them. At 24 ft. from the water the depth was 6.56 ft., but near the river the maximum was only 3.28 ft.

To reduce the inflow, old rails were driven as piles and pointed 12x13-in. timbers were placed to form a cofferdam, in front of and behind which freshly mixed concrete in sacks was dumped to prevent scour. A pump inside the cofferdam kept down the water. Abutments of granite masonry were then built near the ends of these cantilever mattresses. As these methods would not provide against scour during the next wet season, a through bridge of longer span was ordered, massive foundations for this being constructed 13 ft. below river level. This bridge was opened in December, 1925. By that time the floods had begun, so the 62-ft. span was removed, and the following week the river undermined its foundations, causing their collapse. Special defence works protected the new bridge until the tunnel on the relocation was ready for traffic.

Tunneling was expedited by driving an adit or lateral drift from the face of the cliff to the line of the tunnel, so that four headings could be worked. This adit was level with the top heading of the tunnel, as shown. The reason for this arrangement was the difficulty of getting and keeping skilled labor in this unhealthful district. A shaft from the surface was impracticable, but the adit served the same purpose and provided ventilation for the work after the headings met.

Tunnel—The tunnel is on a grade of 3 per cent, with its south approach on a 4 per cent grade. Its total length is 1,640 ft. It has a height of 19.71 ft. above floor level, with an arch of 7.8 ft. radius having its spring line 11.8 ft. from the floor. The width at the bottom is 13.8 ft.

From each of the four faces a top heading 8x8 ft. was driven and was then enlarged to the finished dimensions of the arch for the whole length of the tunnel. Then, working from both ends, the bench was removed. In the arch, mucking was done by hand, the excavated material being removed through the adit by narrow-gage cars and dumped into the river. The remainder of the muck was removed at the two ends. The widening was done with drifters mounted on vertical columns, and this work continued while the benches were being excavated. The rock from the benches was removed by scrapers operated by hoists on a steel frame mounted on wheels. The scraper dragged the broken rock up an incline and dumped it through holes behind the machine into cars below. A scraper could load a 1-yd. car in two minutes. The cars were operated by compressed air hoists.

Extremely hard granite was encountered, sometimes requiring 21 lb. of 75 per cent dynamite per cubic yard of rock. This grade of explosive shattered the rock into small pieces, so that its extra cost was more than compensated by ease in mucking. Special 1¼-in. hollow round drill steel was employed. In certain sections drills had to be sharpened after working 12 to 15 in. and the tool-sharpening machine was in constant use. Drilling was performed by compressed air drifters mounted on columns.

In the heading it was usual to drill sixteen to twenty holes up to 6 ft. deep, charging with 50 lb. of 75 per cent dynamite, but sometimes the break did not exceed 5 ft. in depth. In some places, 40 lb. of this dynamite, carefully rammed into fourteen or sixteen holes, failed to break to a depth of more than 3 ft. Skilled labor for rock drillers, tool sharpeners and mechanics was at a premium and it was constantly necessary to break in new men. To reduce this labor to a minimum one large unit was used, consisting of a steam-driven single-stage air compressor with a displacement of 2,000 cu.ft. per minute. This machine operated the sharpener, two hoists, two air winches, six to eight drifters and other small units. A portable gasoline-driven compressor served the tool sharpener when the larger machine needed repairs.

Although the plant was located on ground where no floods had caused trouble, twice the work was delayed seriously by large avalanches, which filled the compressor house but fortunately did no great damage.

In connection with the tunnel work, about 3 miles of heavy relocation was completed. This work was started in December, 1925, and the line was opened in August, 1926.

As to ventilation, no inconvenience from gases after blasting was experienced in the early part of the drifting, but later it was necessary to blow in compressed air after blasting; the men generally were able to enter and start work within two hours. As only two shifts in 24 hours were possible, due to lack of skilled labor, the work proceeded without delay from bad air. No deleterious natural gases were encountered, nor did rock temperature hamper operations. It was calculated that under the worst conditions 300 cu.ft. of air per minute was blown into each face for two hours in order to purify the air sufficiently to allow the men to work. The time varied in proportion to the amount of dynamite used. It is thought that if a similar tunnel were to be driven, it would be cheaper and more convenient to install a special plant for ventilation if the heading had a length more than 400 ft.

The work was under the direction of F. F. Hixson, chief engineer of the Central Railway of Peru, who has furnished information for this description. Construction was done mainly by railway forces, but the drilling and some of the mucking were done by contract. The railway supplied all tools, plant and material, including dynamite.

Grade-Crossing Accidents

I think the remedy for grade-crossing accidents lies largely in a campaign of education from the first grade in our schools to the college boys. Report and investigate all accidents where personal injury is involved so as to determine the standard of competency of the driver. See that advance warning signs are properly maintained at crossings. Require school buses and oil trucks to stop before passing over railroad tracks. Prevent building unnecessary highway crossings over railroads. Eliminate state highway crossings by viaducts or subways wherever possible. Enact stringent laws requiring a proper standard of qualifications like those for a railroad man.—*N. D. Howard, a locomotive driver, before American Road Builders Association.*

Widening Heavy-Traffic Street at Pontiac, Mich.

Rebuild Paving and Car Tracks—Sewers and Utilities Along Both Sides—Grade Crossings Paved—Poles Removed—Traffic Handled During the Work

By James R. Pollock and Frank C. Brownridge
City Engineer and Assistant Engineer, respectively,
Pontiac, Mich.

PONTIAC, the home of automobile, coach, motor-truck and machinery manufacturing plants, is a city of 55,000 people, with an area of 18½ square miles, situated 25 miles northwest of Detroit and at the northern end of Woodward Ave., which connects the two cities. The building of Woodward Ave. as a 204-ft. superhighway to the Pontiac city limits added greatly to an ever-increasing volume of traffic, as the city is on a highway trunk line and on a direct route to the lake and pleasure resort region in the north.

To meet the increasing traffic needs an ambitious program of street widening and opening was laid out, the major part of which was the widening and rebuilding of Saginaw St., the principal business thoroughfare and a continuation of Woodward Ave. This widening and rebuilding included 4,345 ft. of street widened from 65 to 120 ft., 545 ft. from 65 to 100 ft., 650 ft. from 94 to 100 ft. and 2,250 ft. from 93 to 96 ft. in the downtown section. The improvement involved not only the repaving but the complete rebuilding of 1½ miles of main thoroughfare. It included also the removal, relocation, rebuilding and repaving of more than 1½ miles of double-track street railway. A view of the work in progress is given in Fig. 1, and Fig. 2 shows the typical construction.

On May 26, 1926, a resolution for the widening and improving of Saginaw St. was adopted by the City Commission and on June 22 the notice of condemnation suit was filed. At the same time C. W. Ham, city manager, was instructed to take the necessary steps to proceed with this work. The task of securing the right-of-way for the widening was turned over to a local real-estate firm. Negotiations were carried on so successfully that it was necessary for the jury to settle the amount of award for only seven of the 65 parcels of land required. The property acquired was held by 71 owners and 124 mortgagees, trustees and other interested parties. The estimated cost of land and building damage was $507,322, and the actual cost was $506,907.

The original facilities on Saginaw St. were designed for a city of 15,000 and were long since outgrown. Sanitary sewers were in fair condition and served the existing buildings; additional services were not provided, however, nor was the capacity adequate to meet the needs of a rapidly growing city. Storm drainage had been installed on a hit-or-miss system and was entirely inadequate, being hardly sufficient to drain the pavement surface. Water and gas services were fairly well provided, but to a limited capacity. Both sides of the street were adorned by unsightly wooden poles from which were suspended a mass of telephone, telegraph and electric light wires and cables.

For the 120-ft. width it was found more economical to provide sanitary sewers, storm drains, water mains and gas lines on each side of the street, rather than to carry services the entire width of street. From the main lines, services are provided for each 20 ft. of business frontage, carried to or beyond the curb line. In addition, all electric power lines (both primary and secondary circuits), all telephone cables and all fire, police and signal cables are provided for in two duct systems, each of which is nearly 2 miles in length.

Street Railway Track—In the rebuilding of the street the Detroit United Railways, which operates both the local transportation system and the interurban service to the city of Detroit, completely rebuilt its double-track line. The condition of the rails and ties did not warrant their use in the type of new construction demanded by the city. On about 2,000 ft. of street in the business section there existed three tracks, all of which were in disgraceful condition. The plans for rebuilding eliminated one track and called for a new double track in the center of the street. This rebuilding of the street railway system is the more interesting from the fact that the franchise for the Saginaw St. line expired on May 17, 1927, and on May 24 a "day-to-day agreement" was entered into whereby the street railway company agreed to a number of things, chief of

FIG. 1—REBUILDING STREET AND CAR TRACKS

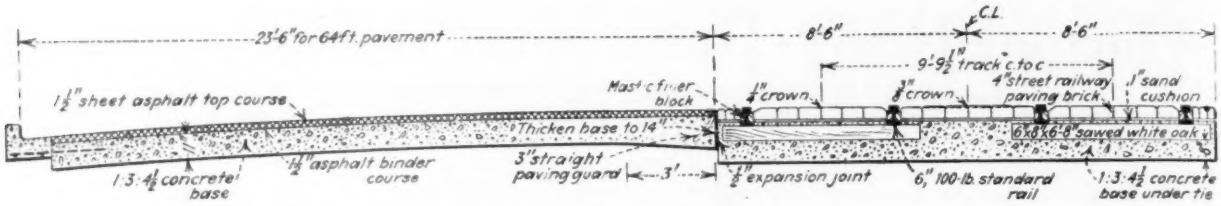


FIG. 2—CROSS-SECTIONS OF SAGINAW ST., PONTIAC, MICH.

which was the rebuilding of its tracks under city specifications, supervision and inspection.

All the plans and specifications for the new construction, with the exception of special-work layouts, were prepared under the direction and in the office of the city engineer and approved by the street railway company, of which J. M. Mudie is chief engineer. G. J. Wagner & Company, consulting engineers, of Grand Rapids, Mich., retained as consultants on transportation matters, acted in an advisory capacity on plans and specifications and helped supervise construction of the tracks.

The track work consists of 6-in. 100-lb., A.R.A.(A) rails, with thermit-welded joints. The ties are sawed white oak, 6x8 in., 6 ft. 8 in. long, 2 ft. c. to c. and cased in a monolithic mass of concrete extending from 8 in. below the ties to 1 in. above them. The paving consists of 4-in. wire-cut paving brick laid on a 1-in. sand cushion and having the joints poured with asphalt filler. Rail filler was used with all regular T-rail sections, together with a special brick nose-block. The concrete was designed for a minimum strength of 2,500 lb. per sq.in. at the end of fourteen days. Actually the test cylinders averaged 2,788 lb. at that time. A carefully proportioned aggregate was used, consisting of a 1:3:4½ mix, with the mixing time not less than two minutes. The concrete was placed as dry as possible consistent with workability. Paving a street intersection and car-track junction is shown in Fig. 3.

In construction, one track was poured at a time and operation was carried on over the other until the concrete had attained the desired strength. This in all cases required not more than fourteen days, as shown by compression test cylinders. In a few instances, where it was impossible to discontinue service, each tie was well blocked and concrete of a richer mix and longer mixing time was poured to within 1 in. of the bottom of the ties. When this had attained sufficient strength, the track was relined and reblocked with shims resting on the concrete and the remainder of the concrete was poured. Where this method was used, the base concrete attained a strength of 2,500 lb. after four days and showed no sign of disturbance from the uninterrupted service.

Paving Construction—For the 120-ft. right-of-way an 80-ft. pavement was designed, with 20-ft. sidewalk on each side. This provides for a double-track street-car line, four 10-ft. lanes for moving traffic and two 10-ft. lanes for parallel parking. The wide parking space was provided for two reasons: If parking is prohibited during rush hours, the street will accommodate eight lanes of moving traffic; and the wide parking space will allow greater ease and safety in parking, with less inconvenience to moving traffic.

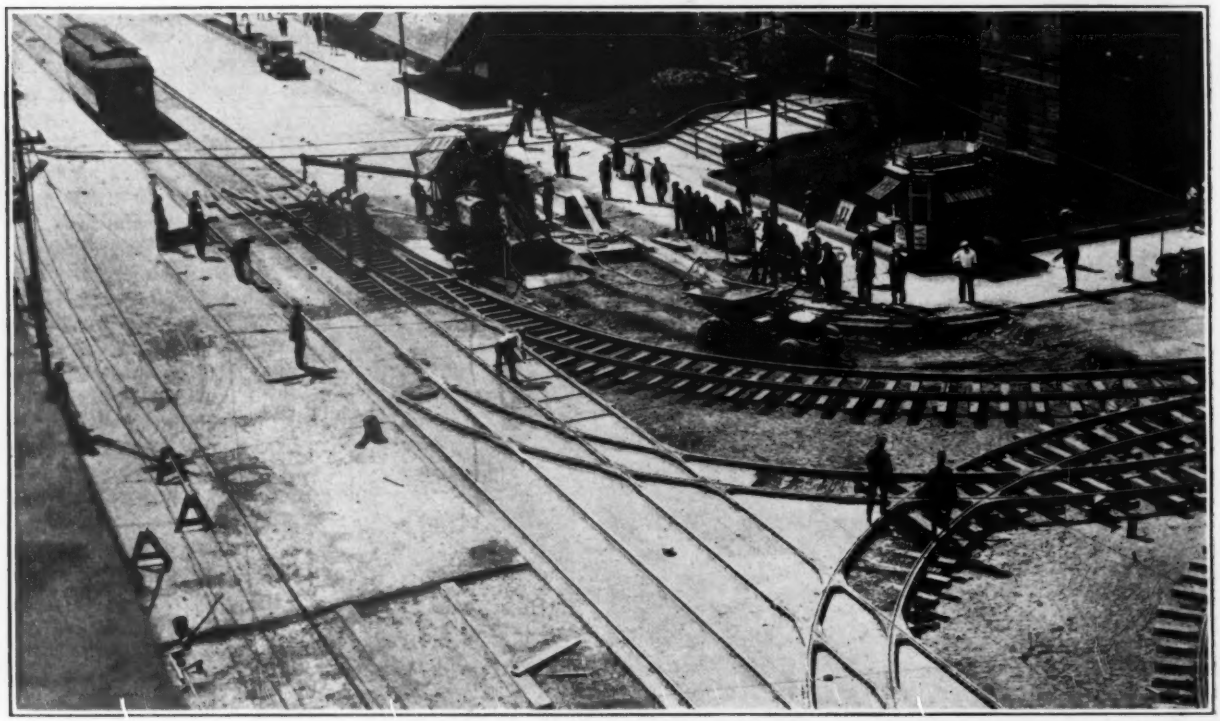


FIG. 3—PAVING TRACKS AT STREET INTERSECTION

The pavement is of a heavier type than we have found on record in other cities, and is built with the hope that it will withstand the unknown requirements of future traffic. The pavement base, of 1 : 3 : 4½ concrete, is 11 in. thick, reinforced by ⅝-in. rods spaced 2 ft. c. to c. longitudinally and ½-in. rods 3 ft. c. to c. laid crosswise. Adjoining the street railway section, the base is thickened to 14 in., which decreases to the regular thickness in a distance of 3 ft. from that section. A 3-in. straight paving guard doweled to the base forms a division between the asphalt surface and the street railway brick paving. That

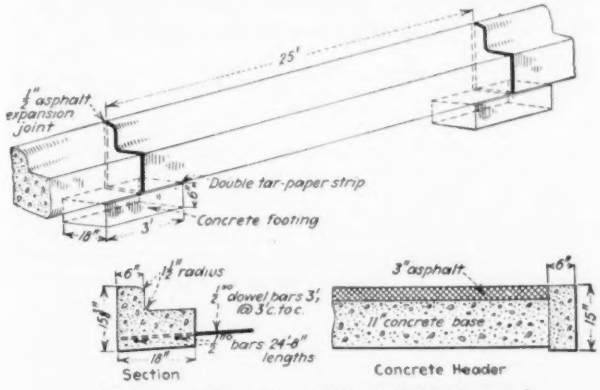


FIG. 4—CURB AND PAVEMENT DETAILS

paving is completely separated from the street pavement by a ½-in. expansion joint extending from the surface to the subgrade.

Novel Curb Design—A departure from current practice was made in the design of the combined curb and gutter. In place of the usual short sections, a 9-in. reinforced-concrete monolithic curb and gutter was built in 25-ft. sections, each end of which was supported on concrete footings 3 ft. long and 6 in. deep with a ½-in. expansion joint between sections. In addition to the longitudinal reinforcing, consisting of two ½-in. round bars, the curb and gutter is doweled to the pavement base by ½-in. bars 3 ft. long and spaced 3 ft. c. to c. The curb was cut back to provide for existing driveways, but no provision was made for future entrances, it being considered that the demand for these on a business street will be limited.

Handling Traffic—During the rebuilding of the street the interests of the merchants and business men were held of paramount importance. All underground work was carried on without closing the street, and the work was confined to limited areas until finished. All backfilling from excavations was mechanically tamped in thin layers. In some instances additional dirt had to be supplied to fill the trench completely, showing that a compaction had been secured greater than that of the original soil. By keeping the various activities spread apart no portion of the street was closed for any great length of time, although it was necessary to barricade the same area more than once. The contract for the paving was awarded the Schaefer-Thompson Construction Company, a local firm. The various operations, involving excavation, curb and gutter, concrete base and asphalt surface, followed in quick succession. The contractors had an aggregate proportioning plant set up near the work and materials were hauled direct by trucks to the mixer over the subgrade.

Asphalt Paving—The sheet asphalt surface was laid by the Michigan Asphalt Paving Company, Royal Oak, Mich. The binder course was made from crushed hardheads ranging in size from 1¾ in. downward. This conglomerate material is very hard, running largely to flint, quartz and granite. For this reason it was not considered necessary to make as close a binder as would be required with soft limestone. About 150 lb. per sq.yd. was laid and the contour was definitely determined by using a template after raking and before rolling. The template was set 2 in. higher than the concrete strike to allow for ½-in. compression, and back rakers were compelled to fill up depressions and pull off mounds before rolling. Whenever the width of the street permitted, the binder course was cross-rolled and at least every joint was cross-rolled. As the sand and stone were each carefully weighed, the binder course presented a continuous uniformity of color with a rich gloss due to the partly opened binder and a contour as nearly perfect as could be made.

After much thought, inquiry and investigation as to the relative merits of 1½-in. and 2-in. top, it was decided to use 1½-in. thickness, more for the element of compression than any consideration of cost. Actually 1¾ in., or 175 lb. per sq.yd., was laid to guarantee the minimum of 1½ in. The mixture contained 10.2 to 10.4 per cent bitumen with 18 per cent 200-mesh material. This mixture received a carefully combed raking, after which the template, raised ½ in. above the finished contour, was struck every foot and the resulting marks or impressions were treated with lutes. The surface rolling was done with a 14-ton tandem roller, circle rolling the top after

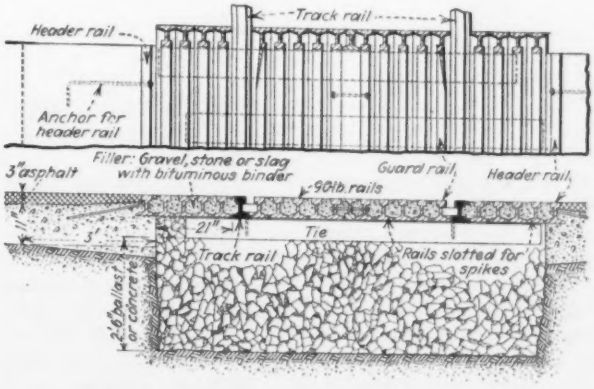


FIG. 5—PAVING FOR GRADE CROSSINGS
Ties staggered to carry outer rails of paving. Rail ends and heads of guard rails beveled. Middle rail inverted and bolted.

one straight pass up each side. The finishing was done with two 8-ton tandem rollers, cross-rolling in reversed position to each other, with the pony end of one covering the path of the large wheel of the other.

Railway Track Crossings—Two lines of the Grand Trunk Railway cross Saginaw St. about ¾ mile apart. These crossings will be of a semi-permanent, solid rail type, shown in Fig. 5. On a subgrade excavated to a depth of 30 in. will be hard crushed rock ballast with oak ties and new rails. The ballast will be well tamped and struck off about 2 in. below the top of ties to allow for some settlement. The surface proper will be made of T-rails laid with their bases touching and spiked to the ties. The spaces between rail heads and webs, except for the flangeways, will be filled with ¼- to ½-in. slag tamped in place and treated with hot asphalt. The area

within the street railway strip, including the diamond crossings, will be surfaced with either precast reinforced-concrete blocks or cast-steel paver plate units.

Poles and Safety Zones—An unusual and gratifying feature of this 1½-mile of street rebuilding is that the only poles will be combined light and trolley-span support poles, 120 ft. apart. These poles are of fluted steel with old-bronze lacquered finish and are 23 ft. high. Each pole carries an ornamental cross-bracket supporting two 600-cp. lights. Before adopting this pole exhaustive tests were made at the manufacturing plant, which showed that it corresponded in deflection to a 6-7-8 in. tubular steel pole weighing 887 lb., except

FIG. 6—SAFETY ZONE AND PLATFORM
This view was taken before the old wood poles and overhead wires had been removed.

that the safe load on the fluted pole was 3,500 lb., as against 1,544 lb. for the tubular pole. Under a load of 2,000 lb. the deflection was only 5¼ in.; at 4,000 lb. it was 11⅝ in. and upon removal of the load the pole returned to within ⅜ in. of its original position. The vibration tests also were satisfactory.

Traffic is so heavy and constant that safety zones with platforms were installed at all important street railway stops in the downtown district. These zones, Fig. 6, are of the raised concrete type, provided with a protective curb and iron railing with a splash apron and with a caution light at the end of each zone. All important street crossings are protected by stop lights, the timing of which is progressive. In addition to the lights, the crossings have galvanized metal markers, and it is hoped that these, in conjunction with the lights, will discourage jay-walking and minimize traffic accidents.

Special Assessment—An unusual feature of the entire project was that it was financed entirely by special assessment. Five districts were established and assessed for the widening and improving: (1) For a distance of approximately ½ mile below the improvement, with frontage on Woodward Ave., the assessment was $10 per front foot. This assessment was on the theory that the property had paid no portion of the cost of paving Woodward Ave. and should contribute substantially to the cost of improving the main thoroughfare. (2) An assessment of $40 per front foot was made for improving that portion of street which was widened from 65 ft. to 120 ft. (3) An assessment of $30 per front foot on that portion widened from 65 to 100 ft. (4) An assessment of $20 per front foot on that portion of the street which was repaved. (5) The balance of the cost was assessed on the city at large, and on the basis of the assessed valuation amounted to $2.56 per $1,000. The frontage assessment was made by the use of the Somers rule, which establishes the standard business lot as being 100 ft.

The entire cost of the widening and improving has been about $1,900,000, or $240 per lineal foot of street.

Oil-Well Pollution Necessitates Auxiliary Water Supply

Oil and Salt Water From Distant Wells Lead Monroe, La., to Store Flood Flows—Pumps, Filters and Meters Added

By C. K. Mathews
Associate Engineer, Burns & McDonnell Engineering Company, Kansas City, Mo.

Just as Coal Mine Wastes in Pennsylvania have for decades past well nigh or actually ruined public water supplies in that state, so in recent years have the water supplies of numerous cities in Louisiana, Texas, Oklahoma and Kansas been made almost or quite unusable by oil-well wastes. The following article tells how Monroe, La., met the situation created by wastes from wells a hundred miles distant, in another state, at the same time giving its water-supply system a much-needed general overhauling from the fire insurance rating viewpoint, with universal metering as an aid to that end and to meeting oil-well pollution conditions. —Editor.

THE Ouachita River, flowing along the entire 5-mile length of Monroe, La., provided the city a good and ample water supply until the development of the Eldorado and Smackover oil fields in Arkansas, a hundred miles away, caused its pollution by large quantities of oil and salt water. Oil was soon eliminated from the river, but as a great number of the original oil wells eventually flowed salt water and as other wells were drilled the concentration of sodium chloride in the river for about six months of each of the past two years amounted to more than 400 p.p.m., with a maximum of about 2,000 p.p.m. This concentration varied from day to day and for samples taken simultaneously only a few hundred feet apart. The concentration was occasionally increased by freshets in the headwaters flushing out the pools maintained by

BAYOU DE SIARD AT JUNCTION WITH OUACHITA RIVER
Site of impounding dam and new low-service pumping station. Storage of flood waters is being provided in this bayou to permit shifting of the supply from the river when most highly polluted by oil and salt from oil wells in Arkansas.

several U. S. government dams above Monroe. The dams are of the removable "needle" type and the periodic removal of the needles allowed "slugs" of salt water to pass down, thus increasing the salinity of the water supply.

The city had no means of legal protection or redress, because of the lack of federal legislation covering the pollution of interstate waterways. The damage was not offset by increased prosperity, as might have been true if the oil fields had been near by. A bond issue of $600,000 was authorized by the voters in February, 1927, for improving the quality of the water supply and for other improvements to the water-works system to reduce fire insurance rates. Contracts for constructing most of these improvements were let in September, 1927.

The city had started a construction program in 1920, but the funds available were expended when the power plant, low-service station and 1-m.g. coagulating basins were completed. These basins alone have since served for treating the city water supply but with unsatisfactory results even after makeshift alterations. The quality of the water had been further affected by its use as cooling water for a barometric condenser before delivery to the basins, the temperature of the water delivery to the city ranging from 100 to 115 deg. F.

The low-service pump station consisted of two frame houses movable on inclined tracks by cable and winch through a vertical distance of approximately 50 ft., which is the range of elevations between high and low water in the river. Variations in length of discharge pipe were made from one set of pumps by universal joint and from the other by inserting or removing short sections of flanged pipe. This arrangement had caused considerable trouble and expense for repairs and operation. During the high water of 1927 it was necessary to set the pumps on temporary foundations in the rafters of the pump house to keep above the water.

Storage facilities and the distribution system were inadequate. Fire pressure was obtained by motor pumpers. The organization of the fire department *per se* was complete and efficient. The city was rated as second class by the Louisiana Fire Prevention Bureau.

The requirements to be met by the engineers resolved themselves into the furnishing of an adequate supply of pure, potable water, fit for industrial use, satisfactory low-service facilities, and pumps, storage and distribution system sufficient to raise the underwriters' rating to first class on a state basis.

There were no meters and the only records indicated an average pumpage rate equal to 130 g.p.d. per capita throughout the year. This rate is much higher than that of any other city in the state, but is explained by the natural waste accruing because of the lack of meters. The first recommendation, therefore, was that the city begin immediately a program to meter every service. Design for the system was therefore based on an assumed future average daily pumpage of 100 g.p.d. A population of 40,000 estimated as of 1940 was used as a basis for design, making an average rate of 4 m.g.d. A maximum daily rate of 6 m.g.d. and a maximum hourly rate of 9 m.g.d. were assumed for conditions when all meters are installed. Fire flow was calculated to be at a rate of 6 m.g.d.

As no practical method of eliminating sodium chloride from a municipal water supply is known, it was necessary to provide an additional supply. The possible sources of supply were the Ouachita River, with an auxiliary supply during periods of high salt concentration; Bayous De Siard, Cheniere, D'Arbonne and Bartholomew (tributaries of the Ouachita, 3 to 20 miles from the city), or a well supply. There are no other drainage areas large enough to consider for impounding flood flows.

Well supplies are obtained in the vicinity of Monroe from four principal horizons at depths ranging from 30 to 2,000 ft. The quantity of water obtainable increases with the depth, but contains sodium chloride and bicarbonate up to 300 and 400 p.p.m. and greater, the mineral content increasing rapidly with the depth. The

OLD LOW-SERVICE PUMPING STATION OF WATER WORKS OF MONROE, LA.

Ouachita River station, to be retained for emergency use. Pump houses and pumps raised and lowered on inclined track through 50-ft. vertical distance by hand winches and cable. New low-service pumping station to be constructed at Bayou De Siard. High-service pumps being installed in new pump building at present plant site.

immediate presence of a large gas field was considered as increasing the possibility of a still higher mineral content in the underground water in the near future. The unsatisfactory quality of the water when obtained in sufficient quantity for a municipal supply, with the possibility of further pollution and the probable decrease in quantity with usage, constituted the basis for rejection of this source for a permanent supply.

Bayou Bartholomew discharges into the Ouachita River about 20 miles north of Monroe. The stream rises in Arkansas in what was considered by the Louisiana Geological Survey to be potential oil-producing territory. The expense of developing this source would have been in excess of the funds available, and in any case the source might have to be abandoned at any time if the headquarters were polluted by oil development. Bayou D'Arbonne is a small tributary of the Ouachita, rising in the neighborhood of the Eldorado oil field, and was receiving considerable salt water. Bayou Cheniere is a small tributary of the Ouachita on the west side of the river. Before entering the river it spreads out in what is known as Cheniere Brake, a stagnant swamp.

Bayou De Siard is a "distributary" of the Ouachita River, characteristic of many of the "bayous" of the delta country. During high water this bayou serves to divert part of the flow of the Ouachita and Bayou Bartholomew, discharging back to the river about 2 miles north of Monroe. It has practically no drainage

area, the ground sloping downward away from its banks. It is dry during most of the year except for stagnant pools, and is covered with vegetation. Its use was, therefore, limited to a possible impounding reservoir for a supply auxiliary to the Ouachita River. Calculations indicated that sufficient storage capacity was available in this bayou to furnish the city with water at the design rate for the six months of high salt concentration in the Ouachita River. The utilization of this auxiliary source necessitated the construction of an impounding dam and low-service pump station near the mouth of the bayou, and about 2 miles of force main. Water stored in this reservoir would probably have considerable color, taste and odor.

The conclusion as to the most desirable source of supply, after consideration of the facts summarized herein, was to use the Ouachita River during high dilution and to store an auxiliary supply in Bayou De Siard for use during the period of high salt concentration. An earth embankment was recommended for the impounding dam, the crest to be above maximum high water in the river, at which elevation the Bayou Bartholomew would act as a natural spillway. The low-service pumping station, for which contracts will soon be let, will be a reinforced-concrete structure with top elevation above high water and extending down below low-water elevation, thus making its operation independent of the stage of the river.

A modern rapid sand filtration plant of 6-m.g.d. capacity is being constructed for treating both the river and reservoir water. The present coagulating basin is being remodeled to serve as an aërator and for primary alum treatment for taste, odor and color reduction. The temperature of the water is to be lowered by the installation of a surface condenser in place of the barometric condenser.

High-service pumps are being installed with a total capacity equal to the maximum daily rate plus fire demand, or 12 m.g.d., with booster pumps of 12-m.g.d. capacity for fire service. A 1.5-m.g. clear well is being constructed to provide storage for a six-hour fire at the design rate. An elevated steel tank of 0.5-m.g. capacity is being erected near the business district for the purpose of supplying the estimated excess of maximum hourly rate over maximum daily rate. This storage will also serve as a fire reserve immediately available at a pressure equal to that from the fire pumps. Feeder mains have been provided for serving the extremities of the town and for a loop around the high-value district, and the city has been assured that the improvements outlined will give the desired insurance rating.

The contracts let amount to $463,571, and the estimated cost of the dam and low-service station is $105,000, making a total of approximately $569,000 for the completed improvements. The Burns & McDonnell Engineering Company of Kansas City, Mo., and Los Angeles, Calif., is engineer for the work.

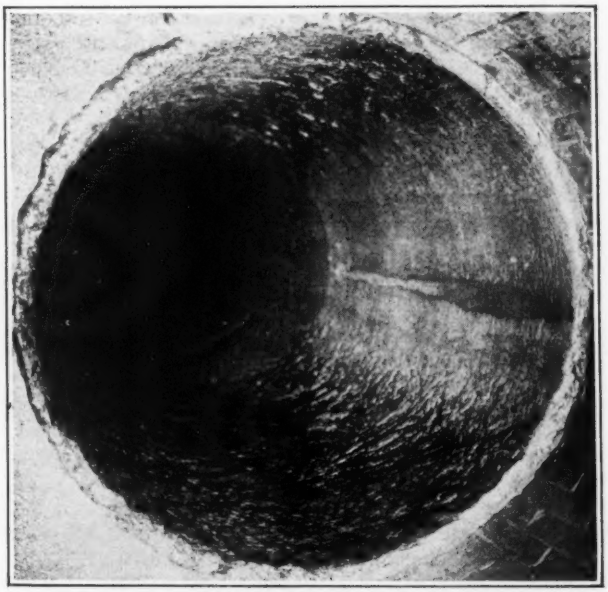
Friction Loss in a 42-In. Sewage Force Main at Baltimore

Tests in Main a Mile Long Showed Hazen and Williams' $C=102$ to 104 and Kutter's $n=0.0139$ to 0.0144

By C. E. Keefer and R. T. Regester
Engineer of Sewage Disposal and Junior Engineer, respectively, Bureau of Sewers, Baltimore, Md.

ALTHOUGH many experiments have been conducted to determine the friction losses when pumping water through cast-iron force mains and the literature on the subject is extensive, no data have been found on friction losses when pumping sewage through cast-iron pipes. The lack of such information prompted the conducting of experiments at Baltimore.

The force main in which the loss of head was observed is 42 in. in diameter, 5,280 ft. long, and connects the pumps in the Eastern Ave. sewage pumping station with a large intercepting sewer. The main consists of both Class A and B bell-and-spigot cast-iron pipe, made in accordance with the specifications of the New England Water Works Association. The pipe contains one 42x21-in. Venturi meter, four 42-in. gate valves, one $\frac{1}{4}$ bend, two $\frac{1}{8}$ bends and twelve $\frac{1}{16}$ bends. The force main was laid in 1909 and has been in service since 1912. Recent observations of the force main showed that the interior was covered with a coating about 1 in. thick. This coating was black, with the surface covered with gray slime. When the deposit was removed, the pipe was entirely free from tuberculation. The coating



INTERIOR VIEW OF 42-IN. SEWAGE FORCE MAIN

RESULTS OF FRICTION TEST ON 42-IN. CAST-IRON SEWER FORCE MAIN, BALTIMORE, MD.

Sewage Pumped, M.G.D.	Velocity, Sec.Ft.	Total Head, Ft.	Static Head, Ft.	Estimated Head Loss Due to Bends and Venturi Meter, Ft.	Velocity Head, Ft.	Friction Head Based on Straight Pipe, Ft.	Friction Loss, Ft. Per 1,000	C Hazen and Williams	n, Kutter
28.5	4.55	69.73	56.00	1.89	0.32	11.52	2.182	102	0.0141
28.6	4.56	69.39	55.96	1.89	0.32	11.22	2.125	104	0.0139
23.6	3.77	65.23	55.62	1.25	0.22	8.14	1.542	102	0.0142
24.2	3.86	65.81	55.66	1.29	0.23	8.63	1.634	102	0.0144
24.1	3.85	65.58	55.66	1.29	0.23	8.40	1.591	103	0.0142

when dried contained 35.9 per cent organic matter, 34.3 per cent iron and 5.9 per cent insoluble silica. The accompanying view shows the interior of the pipe at its outlet.

The pressure head in the force main was determined immediately beyond the discharge of the pump by means of a calibrated pressure gage. The elevation of the surface of the sewage was measured at the outlet of the force main. During the tests stop-planks were placed beyond the discharge point in order to keep the pipe completely filled. The flow of sewage was measured by the Venturi meter in the force main.

Results of the investigation are given in the accompanying table. The values of C in Hazen and Williams' formula range from 102 to 104, and n in Kutter's formula from 0.0139 to 0.0144. The loss of head due to the Venturi meter was calculated by the formula $h = 0.00168\,v^2$, and the loss due to the bends in excess of that in straight pipe was determined by the formula $h = kv^{2.25}$, as developed by W. E. Fuller. No allowance was made for the loss of head due to the wide open gate valves. Although the sectional area of the pipe was reduced due to a layer of slime, the calculations were based on the inside diameter of the pipe. The temperature of the sewage flowing in the force main was 52 deg. F.

The experiments were made under the general direction of the writer, with the field work handled by J. S. Gorsuch. Charles F. Goob is chief engineer of the department of public works, and M. J. Ruark is sewerage engineer.

Po River Flood-Control Works

Long-Time Protective Operations Show Value of Multiple Levees—Bed of the Po River Not Rising

LAST September John R. Freeman, of Providence, made an extended inspection trip over the flood-control works of the Po River in northern Italy, where regulating operations have been in progress for several centuries. A manuscript monograph reporting Mr. Freeman's observations on this trip forms the basis of a paper to be presented before the American Society of Civil Engineers. A brief summary of some of the notes and conclusions of this monograph is given here because of its possible bearing on river control in the United States, especially that of the Mississippi.

The Po drains one-third of the area of Italy, and is the country's most important stream. It flows eastward through the plains of Lombardy from the vicinity of Turin to the Adriatic about 30 miles south of Venice. Its tributaries drain the southern slopes of the Alps and the northern slopes of the Apennines; they are largely of steep slope until they reach the floor of the main valley. The river is about 300 miles long east to west (425 miles along the river course). It carries much sediment, of which the finer fraction is carried to the mouth and builds out the delta. Records of shore lines covering a period of 2,000 years indicate a total extension of the river mouth of 15 to 20 miles out into the Adriatic within the time of history. The oldest (Etruscan) shore line, which passes a few miles east of Ferrara and Adria, is marked by a line of sand dûnes, but those of subsequent periods are not thus evident on the ground. Extension of the delta during recent centuries has gone on at the rate of nearly ½ square mile per year; the present increase is about 160 acres per year, but a century ago it was 530 acres per year.

Annual rainfall on the drainage area (27,500 square miles) is about 42 in., and the total annual runoff ranges from 52 to 68 per cent of this amount. The maximum flood discharge in 1917 was 300,000 sec.-ft.; an even larger discharge occurred in 1926, in a flood beyond all prior records, which caused numerous levee breaks in the middle section of the river, though widespread damage was prevented by the series of secondary dikes. The flood slope of the river decreases from more than 2 ft. per mile in the upper part of its main course to about 0.6 ft. per mile in the delta section.

For many years the statement has been repeated in river literature that sediment deposits have raised the bed of the Po above the level of the surrounding bottom lands. This is not the case, although a smaller neighboring stream, the Adige, has thus raised its bed. Maximum flood elevations of the Po have increased in the course of time, however, probably due to more complete confinement by levees and to the extension of the length of the channel through the delta. Work is now in progress on a general program of raising the levees 1 m. (3.3 ft.) along the lower river, in view of the unprecedented flood stage of 1926.

The Po and its torrential tributaries have been a source of flood trouble from time immemorial, and the tributaries have long been leveed. Delta cones have formed where these tributaries debouch on the valley floor, and here their beds have been raised.

Following the great flood of 1917, elaborate efforts were begun to collect hydrographic data. The number of rain gages in the basin was increased to nearly 917 (one for every 30 square miles, because of the wide variations in precipitation from mountain to valley), the river gages to 137, and discharge gaging stations to 66. In addition 123 stations for measuring groundwater level were established.

The topography and hydraulics of the Po Valley are affected by a progressive slow earth tilt downward to the east. At Ravenna and at Venice structures known to have been a few feet above water some centuries ago are now below water, and large areas of cultivated land within ancient dikes easterly from Adria are now 1 to 3 ft. below sea level.

Levees at many points are as much as 25 ft. high, at some points even considerably higher. Top widths are 16 to 23 ft., and the crests are utilized for main highways. The traffic on the roads helps to keep away burrowing animals such as muskrats. Waterside slopes are 1 on 1½, landside slopes 1 on 2, usually with a berm or banquette at mid-height and sometimes another near the foot. The levee material generally is fine sand, and both in this respect and in foundation soil the Po Valley presents more favorable conditions than that of the Mississippi. In a part of the region of highest flood stages there are two parallel lines of main levees, the rear one providing a second line of defense. Elsewhere a network of road embankments gives equivalent secondary protection. In many sections a further but lower dike has been built along the river bank to permit agricultural use of the flood land inside the main levees in all years but those of high floods.

At intervals of a few miles large brick storehouses

for sandbags are maintained, for use in flood emergencies. The valley population is fully organized for flood-protection work, and thousands of men can be mobilized for levee topping and slope protection works. In the unprecedented flood of 1926 more than 25 miles of continuous sand bag cofferdam about 3 ft. high was built with wonderful speed on top of the main dikes. The flood otherwise would have overflowed the main dikes to the depth of more than a foot. A thorough system of flood forecasting and telegraphic warning has been established.

Narrowing the river in the reaches between bends is proposed as an aid in preventing the formation of cross-over bars and reducing dredging. Because of the works in progress for narrowing the low-water channel by means of spur dikes, retards and training walls it is expected to obtain a navigable channel about 8 ft. in depth all the way from the Adriatic up to the great industrial district around Milan, suitable for barges of about 600 tons capacity. This will connect also with an important system of existing canals which serve also for irrigation and drainage. This hydrographic investigation and the improvements are all under the supervision of the national department of public works.

Increasing Capacity of a German Sludge-Digestion Plant

By Albert Kozma
Assistant Engineer to Alexander Potter, Consulting Engineer, New York City

When visiting Essen, Germany, in 1927, I was greatly impressed by the novel method developed by Dr. Pruess, managing engineer of the Emschergenossenschaft, to increase the capacity of separate sludge digestors. He built a supplementary sludge-digesting tank at the Essen-Nord plant, in addition to the eighteen old Imhoff tanks, to take care of an increased population of 180,000. Later he increased the efficiency of this tank 100 per cent by installing two screw pumps to agitate the sludge. (See Fig. 1 and its sub-title for details.)

The pumps are run about two hours a day. They lift the ripe sludge layers from the bottom to the top and sprinkle them on the surface. According to Dr. Pruess, this is sufficient to mix the fresh and ripe sludge and to separate the decomposed substances and the methane and carbon dioxide gases formed during decomposition. Thus the bacteria get in more intimate contact with the sludge and work more efficiently. The rising gases in themselves, or even mechanical agitators, such as paddles in Dorr tanks, cannot accomplish the same results; but it could be done by centrifugal pumps. By reversing the pump the floating scum is removed from the top and made harmless by mixing it with ripe sludge.

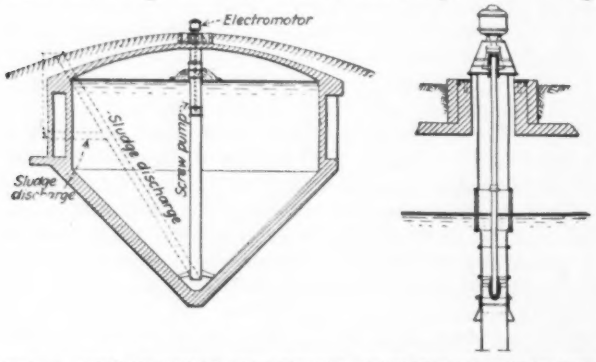


FIG. 1—SCREW PUMP TO AGITATE SLUDGE IN SEPARATE DIGESTION TANK, ESSEN-NORD, GERMANY
Tank has a capacity of 53,000 cu.ft. Pump of 150-g.p.m. capacity driven by 3.9-kw. motor at 750 r.p.m.

Normally the digested sludge contains 90 per cent of water, whereas of the 10 per cent of solids 45 per cent is organic matter; but the water could be reduced to 75 per cent and the organic content of the solids to 32 per cent by a longer sludge-detention period.

The earth embankment that forms the tank prevents heat losses. Dr. Pruess thinks that further increase in efficiency could be effected by heating the sludge with the gas collected in the hood.

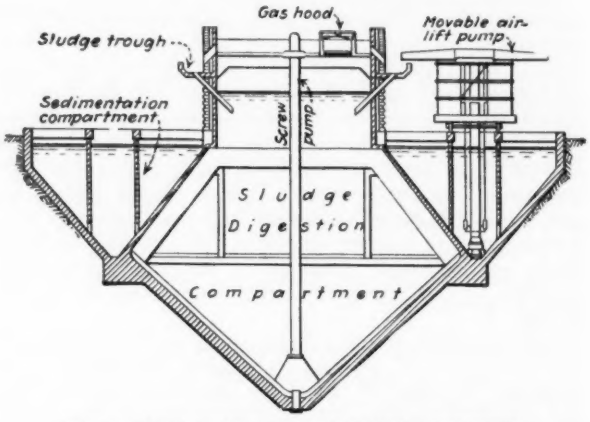


FIG. 2—TWO-STORY SEPTIC TANK AT ESSEN-FROHNHAUSEN, GERMANY
Settling and settling compartments completely separated. Sludge removed daily from sedimentation compartment by a portable air-lift. Normally, the sludge thus lifted is discharged into the digesting compartment, which has a capacity of 25,000 cu.ft. and is designed to serve 25,000 people. When the sludge contains industrial wastes that would interfere with digestion it is bypassed by drying beds.

Fig. 2 shows a two-story septic tank built to extend the Essen-Frohnhausen plant. With this arrangement the heat of the incoming sewage is utilized to keep the temperature of the digestion chamber high. At this tank also two screw pumps are installed. After 5½ months' initial winter operation good sludge was produced.

The diagrams and some of the data here presented were taken from an article of Dr. Pruess published in *Technisches Gemeindeblatt*, June 5, 1927.

Germany Prohibits Impure Water by Law

A new pure food law in Germany, which came into effect Oct. 1, 1927, expressly includes drinking water among the articles of consumption which may not be adulterated or polluted. Most of the water supplies for German cities are from wells or springs and only when these sources are not easily available are the waters of rivers or lakes used as a supply. Surface waters are purified by means of slow filtration through sand, with the use of some clarifying agent. In recent years there has been a more general treatment of water with chlorine. Berlin's water supply comes chiefly from deep wells and is free from pollution. It requires treatment only to remove the mineral content before being used. Hamburg, on the other hand, takes its supply from the River Elbe and uses the sand filtration method together with a chlorine treatment both before and after filtering.

Minneapolis Construction-Cost Accounting System

Under Compulsory Law of State-Wide Application Detailed Costs of All Public Works Recorded by Comptroller

By Gustave A. Moe
Cost Accountant, Office of the Comptroller, Minneapolis, Minn.

MINNEAPOLIS has a cost accounting system for all public works, improvements and buildings. It was established by an ordinance approved July 12, 1926, under which the city comptroller, Dan C. Brown, chose the writer as cost accountant, effective Aug. 1, 1926. Since then a cost accounting department has been formed and the system has been gradually put into effect. This article relates chiefly to the system as applied to the city engineer's department, which has charge of the larger part of the construction done by or for the city.

Before taking up cost accounting in Minneapolis, its legislative basis will be outlined. Chapter 274 of the Laws of Minnesota for 1921 requires all municipalities and political subdivisions of the state "to keep complete and accurate accounts of all public work and construction and of the cost thereof, done for or on behalf of such municipalities and political subdivisions," whether by "contract or day labor, of an estimated cost of $1,500 or more. Intention to do any such work must be publicly announced. Such construction cost records must show, under proper tabular heads, the "cost of all materials, supplies and services" and the "cost of all labor," the latter when the work is done by the city directly. For contract work somewhat similar data are required. In either case there must be recorded the "cost of all overhead, the cost of engineering and all other expenses involved in the total cost" of construction work in question. On completion, the total cost of the work must be officially announced.

The Minneapolis ordinance already mentioned follows the general lines of the statute as to what cost records must be kept, assigns the work to the city comptroller and requires the co-operation of all the other departments and officials of the city so far as concerned with construction work.

Most of the construction work under the direction of the city engineer is done by day labor. The first project for which this department installed a system of cost accounting was the Cedar Ave. bridge, where about fourteen major accounts with approximately 75 subsidiary accounts were set up. Classified material control and equipment schedules were set up and reports to the engineers are available at cut-off periods. Every two weeks daily labor distribution to all accounts is given the engineer, which affords him the opportunity to change methods of construction during the course of the job or make other changes he may deem advisable.

The other branches of the city engineer's department were next taken up. A school for foremen, timekeepers and cost clerks was established by the cost department. Foremen were instructed in the matter of making reports to the office, material requisitions, transfers from one job to another, final statements of materials used, etc. Schedules were given them showing the type of work chargeable to different operations. For example, on sewer construction to sheathing and bracing account should be charged moving, cutting, trimming for caps; cutting braces, driving, removing and handling of sheathing and bracing lumber. Labor distribution forms to cover each class and type of construction were designed and at present the reports are coming in very much improved.

In each division—paving, sewer, water, curb and gutter—equipment rental schedules have been established and a rental charge is now made to the particular job using the equipment. This charge covers depreciation—which we intend to set up as a reserve to replace equipment—and also repairs and maintenance costs. Together these give a standard rate per hour cost on all types and kinds of construction equipment.

The city has accumulated a large amount of equipment and we are now attempting to put into operation a central control plan, devised by Comptroller Brown, which will tend to reduce the equipment costs to a minimum by standardization of equipment, by salvaging old and obsolete equipment, by rentals to other departments and by proper accounting as to economic life and service. We are also making time studies in the different operations of the construction jobs to ascertain, if possible, any lost motion and to give the engineers all available data on which to base their estimates for future work.

At the completion of each job a report is given to the department head, showing in detail all direct labor and materials used, all equipment and other charges, plus all overhead and the general expense charge. The latter is a charge made by the cost accounting department for services renderd by various city hall departments—the comptroller, treasurer, purchasing agent, civil service commission, city attorney, city engineer and city clerk—all of which is credited to the current fund of the city. At present this charge is 1 per cent and is in addition to all other costs.

The purchase of materials is made through the purchasing agent. A master material control is kept in the city comptroller's office and each department must check to it with their material control and perpetual inventory, which shows at all times quantity used, quantity on hand, amount purchased—all under a coded classification. Yearly inventories are classified accordingly. This affords a two-way check on materials, as cost reports are checked by the cost department as to theoretical amounts required in case of cement, sand, gravel, lumber, etc., for a given project. Material control is then credited for the amounts used on each job.

To assist the engineers a paving repair maintenance report has been formulated by this department. It required going back over twenty years of paving work and assembling the maintenance repair cost against about 3,000 odd jobs of paving put in during that period. Length of service was shown and the cost of upkeep, thereby giving the engineers replacement data.

Street maintenance in Minneapolis is handled by thirteen ward commissioners, each having a separate organization. A completely revised system of accounting has been installed in each ward. This will give the engineer uniform data as to the cost of maintaining streets in all sections of the city.

The work of the cost accounting department has had good effect on the other city departments. Their organization has been strengthened, the costs are lower and will continue to decrease as the system develops. Engineers in the service are becoming accustomed to use the data prepared for them in a manner they appreciate.

Intake Tunnel at San Diego Built by Novel Pneumatic Caisson Method

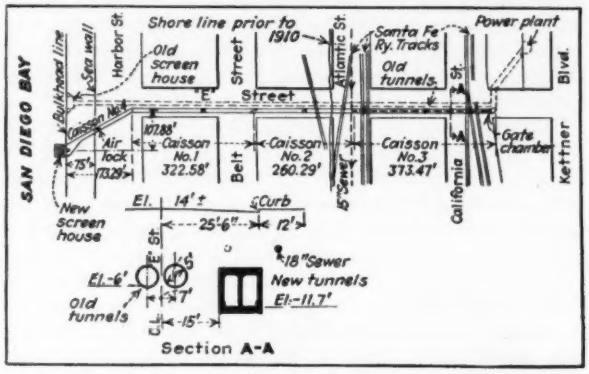
Sides and Top of Tunnel Cast as a Unit in Sections up to 373 Ft. Long and Sunk as Pneumatic Caissons—Excavated Material Placed on Top to Increase Load

IN CONSTRUCTING a new intake tunnel at San Diego recently to provide ocean water for circulating purposes at a steam plant, the entire length of 1,200 ft. was built by the pneumatic-caisson method, sinking each of four concrete sections separately and connecting them up after they were in place.

In planning the work it was found desirable to have the tunnel bottom 26 ft. below average ground surface to secure gravity flow to the circulating pump intake. The tunnel would traverse filled land containing many obstructions, would be below groundwater level and would pass close to and about 6 ft. below two 5-ft. pipes that could not be disturbed. Because of these conditions, the caisson method was selected as the best scheme of construction, and the work was successfully carried out on this plan.

Excavation for each of the four caissons was carried down in open cut to the water line and then a section of the concrete tunnel was cast without a floor and with the bottom edges of the outside walls shaped to form cutting edges. After the concrete had set, the tunnel section became a caisson and was put under compressed air; excavation was carried on inside in usual caisson manner. The excavated material was deposited on top of the caisson for additional loading. This method enabled workmen to remove obstructions as they were met, provided adequate protection for the old tunnels near by and actually cost about 20 per cent less than the estimated cost of the steel sheet piling method that was the next lowest in cost.

Although the completed tunnel was to consist of two 4x8½-ft. barrels, the caissons were built with only a stub of the center wall, the shell being reinforced sufficiently to carry the stresses without the center wall or the floor



GENERAL PLAN OF CIRCULATING WATER TUNNELS AT SAN DIEGO

when braced by temporary 12x12-in. struts just above floor level. These timber struts were placed horizontally 8 ft. on centers, between longitudinal beams in the side walls, and were removed after the concrete floor of the caisson had been poured. The 13-in. side walls were designed as slabs spanning from the roof of the tunnel to these longitudinal beams.

A concrete bulkhead was poured across one end of each caisson with the first pour of concrete. The opposite end was left open for the removal of forms, bearing planks, etc., and when the concrete had set, forms had been removed and the section was ready for sinking, an alumina cement bulkhead was poured in the open end, thus completing the fourth side of the caisson.

Each caisson was equipped with a 4x9-ft. air lock, which served as the main entrance to the caisson, and also with an emergency lock 4 ft. square. These air locks were later converted into manholes.

Short lengths of 6-in. pipe were cast 16 ft. on centers along the center line of the tunnel roof. These pipes extended above the top of the

END VIEW OF CAISSON BEFORE SINKING
Forms have been stripped, open end is ready for closure. Structure for retaining excavated material being erected.

EXCAVATED MATERIAL ON TOP OF CAISSON
One of the 4-in. ejector pipes is discharging in the background. Illuminated rods at sides are for reading levels during sinking.

tunnel and below the uncompleted center wall. During the excavating period they served as openings through which the 4-in. blowpipes were carried, and later they were used for the delivery of concrete for the floor and center wall. As the caisson was lowered short lengths of pipe were added to these vents so as to keep them just above the excavated material placed on the tunnel roof.

When a caisson was ready for lowering, excavation was begun on the inside and material was removed with a hoist bucket through the open air locks until the shoes or cutting edges of the caisson were in 1 or 2 ft. of water. The caisson was then put under air and water level forced down to a point slightly above the cutting edges, excavation and sinking being continued in three eight-hour shifts. Generally the pressure was kept about equal to the hydrostatic head.

Excavated material was deposited by the workmen in a trough sloping down to the open end of one of the 4-in. blowpipes. Each blowpipe was equipped with a quick-opening valve and a long-radius ell entering the lower end of the trough. By opening this valve for a short interval the material in the trough was ejected by air pressure. The material blown out was confined on top of the caisson by the walls of a wooden structure built up for this purpose before sinking began. By this method the caisson was backfilled as it was being lowered into place.

The usual procedure in excavation was first to remove the earth in the center, leaving sufficient material under the walls to support the caisson in a level position. For the most part, sinking or lowering of the caisson was done in 24 hours, the average distance lowered per sinking period being about 6 in.

Air pressure in the caisson was decreased to start the sinking process, the amount of decrease depending on soil and water conditions. While the caisson was sinking instrument men continued level readings on rods attached to the structure. Any unevenness was reported by telephone to the foreman in the caisson, and a portion sinking too fast was retarded by placing wooden blocking under the shoe, whereas a portion sinking too slowly was aided by additional excavation. When the sinking was retarded by exterior skin friction on the side walls, a water jet was pushed down outside the wall to reduce the friction.

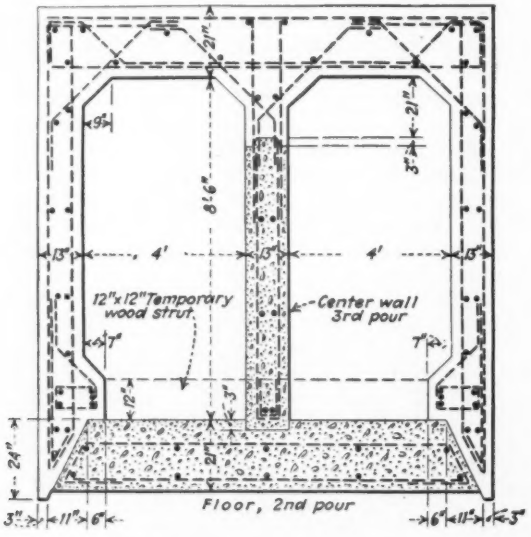
Air was delivered to the caisson at 20 lb. through a 6-in. pipe and high-pressure air (at 100 lb.) through a 4-in. line. These pipes were connected to the caisson with a combination of swinging joints that permitted them to adjust themselves automatically as the caisson sunk. The usual operation was to allow the full supply of low-pressure air to enter the caisson and to regulate caisson pressure by the amount of high-pressure air admitted. Controls were handled by the lock men on top of the main air lock. Each caisson was also pro-

GENERAL VIEW DURING CONSTRUCTION OPERATIONS
Excavation in open cut in foreground; placing forms in center, sinking caisson in background.

vided with a safety valve of the lever and weight type, to prevent any possibility of excessive pressure.

In the excavation of clay or hard earth strata various equipment was used, including picks and shovels, pneumatic spades and gads and high-pressure jets of air and water. Old wooden piling and bulkheads encountered in the caisson were cut off a few inches at a time with sharp pneumatic chisels. Broken pavement, rock and pieces of solid substance were removed from the caisson by locking out through the emergency lock.

No data on similar subjects were found to aid in estimating the quantity of compressed air necessary for this work. It was considered advisable to supply not less than 30 cu.ft. of fresh air per minute for each workman in the caisson, and high-pressure air was required, of course, for operating the pneumatic tools. Two motor-driven compressors were installed, each with a capacity of 500 cu.ft. of free air per minute. This capacity was



CROSS-SECTION OF THE DOUBLE-BARRELED TUNNEL

ordinarily sufficient, although occasionally the number of blowers that could be used for ejecting excavated material was limited by the air supply.

The caissons were maintained as level as possible during the sinking, to prevent undue strains that would crack the concrete. It was impossible, however, to prevent all cracks, and when each caisson was put under air the interior wall and roof surfaces were given a cement wash coat with a brush. This sealed the pores, aided by the additional penetration resulting from the interior air pressure. When cracks appeared they were treated in a similar manner.

When each caisson was down to grade, blocking was placed under the shoes, the soil leveled off and the excess water blown out. The floor-reinforcing steel was then placed, using the temporary 12x12-in. crossbeams for support. The reinforcing steel had been brought into the caisson before it was closed for sinking.

For pouring the concrete floor the 6-in. pipes through the tunnel roof were extended about 10 ft. above street grade. A gate valve and hopper were attached to the upper end of these pipes and a special slide valve was put on the tunnel end. With this arrangement the hydrostatic head in the pipe loaded with concrete was greater than the air pressure in the caisson. Concrete was thus delivered without the use of any air-locking process and was spread manually to form the floor. When the floor was completed, the air pressure was slightly increased, and the caisson was maintained in this condition until the concrete had strength enough to carry the load. The center wall was poured with the caisson decompressed.

While one caisson was being sunk the one adjacent was being constructed, a space of about 3 in. being left between the adjoining ends. When two adjacent caissons were in place with the concrete floor poured, holes were drilled in one of the concrete bulkheads and the space between was filled with grout, which was also forced out around the exterior edges to form a rim or ridge around the joint. The bulkheads were then broken away and a depression was cut in the interior side walls of the first layer of reinforcing steel. This steel was straightened out, cut to the proper length and the steel from the two caissons tied together to form continuous sidewall reinforcement. Finally the interior surfaces of the walls were built up to the proper alignment with a cement gun.

On the ocean end of caisson No. 4 approximately 75 ft. of the structure extended beyond the sea wall, and this projection was to be supported on wooden piles driven to grade with a follower before the caisson was constructed. These piles were driven, inclosed by sheet piling and backfilled with sand to average water level. This procedure formed a support for the caisson similar to that in the trench excavated on the land side of the sea wall, and sinking was done in the same manner as in the other sections.

The tunnel terminated, at its outer end, in a screen house containing trash racks, traveling water screens and bulkhead gates. Connections were so arranged that one barrel of the tunnel could be unwatered for cleaning purposes while the other barrel remained in service.

The work was done for the San Diego Consolidated Gas & Electric Company by the Byllesby Engineering & Management Corporation. The foregoing data were supplied by H. H. Watson, general superintendent of construction of the first-named company.

Production of Electricity in 1927 Shows Increase

Preliminary figures of the Geological Survey on the total annual production of electricity by public-utility power plants in the United States indicate an output of 79,724,000,000 kw.-hr. in 1927, an increase of 8 per cent over the output for 1926. Of this quantity 37 per cent was produced by water power, an increase of 1.6 per cent over the proportion for 1926. In kilowatt-hours the electricity produced by the use of fuel increased about 5½ per cent, and that produced by water power increased about 13 per cent. It would have required about 27,000,000 tons of coal to generate the electricity that was produced by the use of water power.

The improvement in the average utilization of fuels brought about by improvements in plant design and operation during the last few years continued in 1927. Operators of public-utility power plants performed the remarkable feat of generating about 2½ billion more kilowatt-hours of electricity by the use of fuel in 1927 than in 1926 by the consumption of about 150,000 less tons of fuel. From 1919 to 1927 the average quantity of coal required to produce a kilowatt-hour of electricity has decreased from about 3.2 to about 1.8 lb.

Design and Construction of First-Order Leveling Rod

By D. L. Parkhurst
Chief, Instrument Division, U. S. Coast and Geodetic Survey

THE level rod used in first-order leveling, where an accuracy represented by a probable error of not more than 1 mm. per kilometer is required, differs widely from the ordinary Philadelphia rod generally used by surveyors. Construction of this rod presented a number of interesting problems, the solution of which required considerable research, and the manufacture of a special machine for graduating. The rod, shown in Fig. 1, consists of a graduated metallic strip rigidly attached to a metal footpiece, the latter being fastened to a wooden backing which supports the strip.

In order to reduce the effect of temperature changes, the graduated strip, about 3.3 m. long, is made of invar, a nickel-iron alloy having a temperature coefficient of about 0.000002 per degree C., which is about one-fifth that of iron. In other words, a temperature change of 50 deg. F. would cause a difference of only 0.008 in. in the entire length of the strip. This small amount is corrected for by computation, thermometer readings of the temperature being taken while the rod is in use.

The invar strip is fastened by a brass machine screw and two bronze dowel pins to the cast-steel footpiece. The strip is 26 mm. (1 in.) wide and 1 mm. thick. The lower surface of the footpiece is casehardened and ground flat and normal to the surface (also ground) against which a wooden back is fastened. The footpiece was formerly made of cast brass, with a hardened steel plug in the end, but it was found that the part was occasionally bent and that a certain amount of upsetting occurred in use.

The back is made of a single piece of well-seasoned straight-grained white or sugar pine, free from knots or other defects. This is securely fastened to the footpiece by four brass bolts through the face and two brass wood screws in the end. A shallow groove, slightly wider than the invar strip, is routed out through the entire length of the face and deep enough so that the strip is free to move underneath a number of brass washers recessed to set flush with the face. A handle is attached to the back, near the center of gravity.

To prevent swelling, the wooden back was formerly immersed in boiling paraffin, but this was found to add materially to the weight and to destroy the resilience of the wood to such an extent that the parts frequently took a permanent set. It is now treated by applying a heavy coat of raw linseed oil, three coats of orange shellac and two coats of white lead paint. This treatment furnishes excellent protection against moisture and in no way affects the resilience.

The thermometer used for determining the temperature of the strip is accurate to ½ deg. C. and is of special construction, having an unusually fine capillary and a bulk bent backward at 45 deg. This is set in a recess in the wood, the bulb resting against the rear surface of the invar strip.

In order to eliminate any error that might occur due to sagging when the rod is held erect, the strip is placed under tension by a stiff spring, set into a recess in the back and bearing against a small brass angle plate attached to the top of the strip.

The graduations are in the form of alternate squares of black and white painted on the invar strip. As metric units are used, the squares are 1 cm. in width. The problem of applying them with the desired accuracy has been solved by the painting machine shown in Fig. 2. This work was formerly done by coating the strip with white paint, then placing it beside a master scale and transferring the dimensions by means of a steel square and scriber. The black squares were then filled in by hand, a tedious process. It was impossible to obtain uniform width, as the scriber cut a shallow groove of finite width, into which the paint would flow, causing a general tendency for the black squares to be wider than the white. Irregularity of the lines of demarkation was also unavoidable.

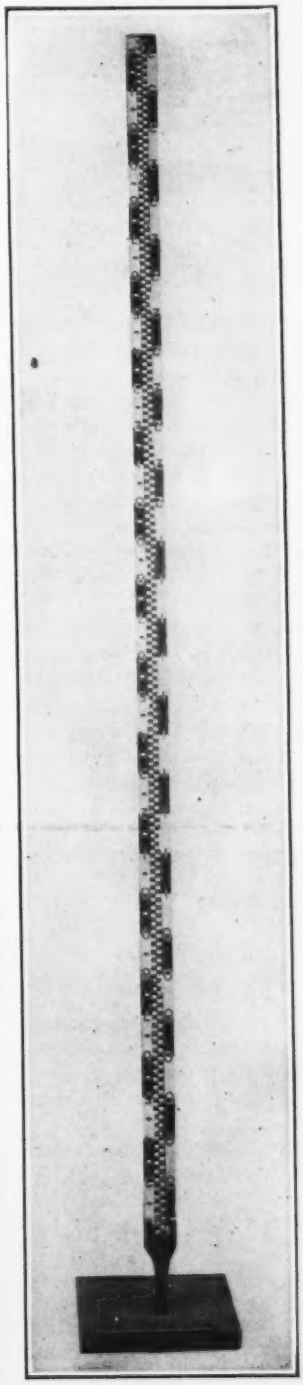


FIG. 1—DETAILS OF GRADUATIONS

The comparison method is used with the new machine, thereby avoiding the necessity for cutting a long and accurate lead screw and for working at constant temperature. An invar bar of the same physical characteristics as the strip, accurately ruled in 1-cm. spaces is located in a groove at the rear of the machine. A microscope is mounted on the carriage, carrying a pair of fine parallel tungsten wires in its focal plane. A small electric bulb placed beside the microscope tube shines down upon the comparator bar, causing the ruled lines to stand out brilliantly. The tungsten wires show black against this brilliant background and the setting of the carriage is surprisingly easy.

The cross-slide of the carriage carries a vertical slide on which is mounted a cup-shaped turreting mask having four rectangular slots 1 cm. wide cut in the rim. The turret is lowered and pressed against the work by a small eccentric and the open space is sprayed with a quick-drying black paint by means of a small air brush. As the mask is raised vertically, no difficulty is experienced with smearing the paint, and it is not necessary to wait until it dries. As soon as a square has been painted the mask is raised, the carriage is traversed to the next space and the process is repeated. The multiplicity of openings is

desirable to facilitate the cleaning away of paint accumulation along the edges of the mask without delay to the work.

All the resulting graduations, both white and black, are of equal width. The lines of demarkation are straight and sharp and the sharpness is enhanced by the thinness of the film of black, which does not provide a raised and shining surface to cause annoying reflections.

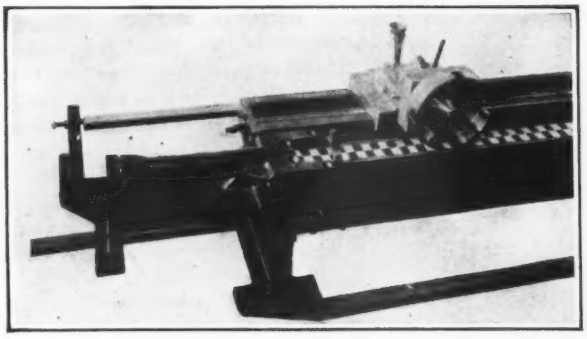


FIG. 2—MACHINE FOR PAINTING GRADUATIONS ON FIRST-ORDER LEVELING ROD
Details of mask, carriage and stop for locating initial meter line. Comparator bar at rear.

In the former process the initial meter line was laid off roughly 1 m. from the foot, a scratch line being made on the metal of the strip at this point, the actual distance being carefully measured later. This gave an odd figure to be used in computation. To remedy this, stops have been provided at the end of the machine, so adjusted that when the strip with its footpiece is placed in position, the 1-m. graduation is exactly 1 m. from the lower end of the footpiece.

As a check on the observations the rear surface of the wooden back is graduated roughly in English dimensions. Both sides of the rod are read and recorded at each station, thus eliminating the occasional gross error caused by an incorrect reading, which might remain undetected if a compensating error of similar magnitude were made on the opposite running of the section.

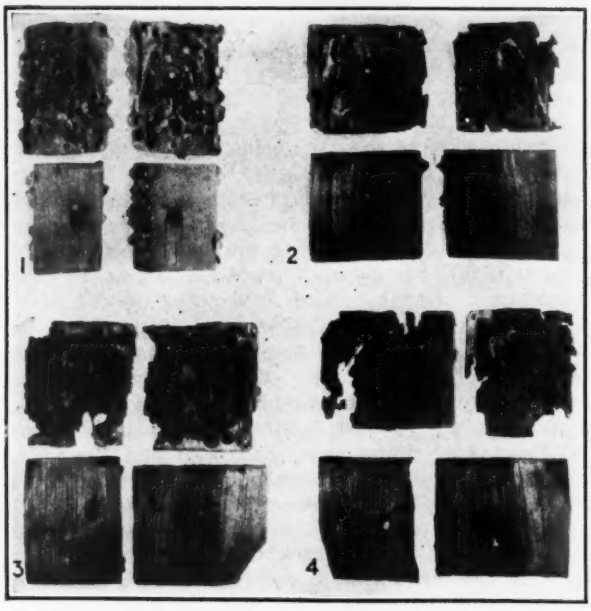
Protecting Timber Against Teredo Navalis

By R. A. Marr and R. A. Marr, Jr.
Consulting Engineer, Norfolk, Va., and Assistant Professor of Civil Engineering, Virginia Military Institute, Lexington, Va.

OPEN-TANK treatment with simple and inexpensive equipment, which may be arranged as a portable plant, has been found efficacious in protecting timber against the attacks of *Teredo navalis*. The method, patented by the writers, is as follows:

A mixture of paraffin and resin is used as the carrier for a small percentage of high-grade creosote oil. The latter, being an active antiseptic, prevents rot and the attacks of marine or land borers. The timber to be treated is immersed in the melted solution, the time of treatment and temperature being varied according to the depth of treatment desired. The wood can be completely impregnated if necessary. After treatment the timber is removed, and when cool is ready for use. Two-year tests indicate that hardwoods can be successfully treated by this method, which is not easily accomplished with a heavier creosote oil. Although but a small percentage of antiseptic is used, the mixture on cooling seals the pores, preventing loss by evaporation or leaching.

The illustrations herewith show four sets of samples which were removed in August, 1927, after more than two years of exposure in waters infested by *Teredo*. Each set was made up of blocks of wood approximately 4 in. square and ¾ in. thick, treated and untreated blocks alternating. These were separated by washers and strung on insulated copper wire with a heavy weight at the end to hold samples in a vertical position. The blocks shown herewith represented a fair average of the set from which they were selected. In every case untreated blocks were riddled. A few of the treated blocks showed one or two small *Teredo* tunnels.



TREATED AND UNTREATED BLOCKS AFTER TWO YEARS IN TEREDO-INFESTED WATERS
Sample 1, hardwood, was tested through the co-operation of the Norfolk & Western Railway. Sample 2, also hardwood, was tested through the co-operation of the Southern Railway. Samples 3 and 4 are Southern pine, tested through the co-operation of the Southern Railway. The exposures were at Norfolk and Pinner's Point, Va.

In this series only 2 per cent by weight of antiseptic was used, in an effort to establish the minimum percentage that would be effective. Another series of tests, using the same method but a higher percentage of antiseptic, is now in progress. Tests are also being made of a preservative solution using the same carrier but with either sulphur or finely divided paris green as the antiseptic.

Mt. Hood Cableway Decision Postponed a Year

Application for a permit to construct a cableway to the summit of Mt. Hood, El. 11,200 ft., in Oregon, was made to Secretary of Agriculture Jardine in the form of an appeal from the adverse decision of U. S. Forester, Col. W. B. Greeley. A description of the scheme was published in *Engineering News-Record*, March 17, 1927, p. 447, and a note on Colonel Greeley's refusal to grant the permit appeared April 21, 1927, p. 647. After an extended hearing in Secretary Jardine's office he decided to postpone action for one year, during which time "a thorough study of the potential value of Mt. Hood and the way in which this can be best conserved will be made by a representative committee."

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Why Not a National System for Rating Welders?

Sir—Since the human element is so important in welding work, does it not seem expedient that welders be required to pass an original rating test and thereafter to submit, from time to time, specimens of their work to be tested, in order to maintain a uniform standard of workmanship? A solution of this problem would be the establishment of a uniform system of rating welders by means of test specimens and the issuance of suitable certificates by some national organization such as the American Welding Society.

Structural steel welders, to take one class, might be divided into two or three grades. First, there is the artist type of welder who has ingenuity plus exceptional ability, who might be rated arc-welder or gas-welder, Grade A. Then there is the welder who is not an artist in his work but who can consistently turn out good dependable welds, who would be rated Grade B. A third class, Grade C, might include those welders who have never mastered overhead welding but who can do satisfactory welding on flat and vertical work. There are many other possible classifications, including the grouping of all low-carbon steel welding in one classification, and much thought and discussion would be necessary in working out a complete schedule.

As a basis for issuing certificates, suitable test specimens might be prepared, sent to some laboratory and broken, and the results forwarded to the certificate-issuing board. The plan should be sponsored completely by some national engineering society, which should work up the classification of welders, the time limit of the certificates, test specimens, testing procedure and the issuing of certificates. From the viewpoint of the engineer, the sponsoring of this scheme by a national organization would, I believe, be preferable to a system of state licensing.

In order to put such a plan into operation, it would be vitally necessary to create a demand for it among the manufacturers of welding equipment, the engineers, the welders, and the employers of welders. Then, if the larger concerns would initiate the program by requiring their welders to pass the examinations and if engineers in writing welding specifications would demand certified welders, the whole plan might be easily and gradually inaugurated.

Bethlehem, Pa., Jan. 24, 1928.

CYRIL D. JENSEN,
Instructor in Civil Engineering,
Lehigh University.

Toe Erosion Below Overfall Dams

Sir—I note on p. 974 of the Dec. 15 issue of *Engineering News-Record* a letter from Sherman M. Woodward, professor of mechanics and hydraulics, University of Iowa, relative to the toe erosion below overfall dams.

Some years ago in connection with the installation of a hollow concrete dam the writer had occasion to investigate this same condition, and examined a number of dams with an idea of arriving at some conclusion whereby this erosion could be overcome, and I am inclosing herewith a copy of a paper containing some information on this subject, which was published in 1914. ("The Construction of Dams," by A. E. Walden; reprint from *Journal* of the New England Water Works Association, Vol. XXVIII, No. 3.)

An inspection of the pool at the toe of the dam will almost invariably disclose that the depth of this pool is about one-quarter of the height of the dam and that stones from the size of an egg to those having a diameter of 10 or 12 in. will be found on the lower edge of the pool, leaving the bottom at the greatest depth comparatively clear except the very largest of such stones.

In studying the conditions during flood on the dam mentioned in the pamphlet, the crest of which was 200 ft. long, it was noted that logs and other floating débris, ice in which rocks were embedded, after striking the pool would roll end over end for quite a period before quiet water was reached that would permit the logs or ice to flow out of the pool and down stream. Based on such study, a pool was constructed at the foot of the dam, having a depth a little over one-quarter of the height, and since that time there has been no further erosion—that is to say, no increase in the depth of the pool. It has, however, at its lower edge become fairly evenly paved with stones that from the wear and shape indciate that they have been rolled over and over again until they found a permanent position.

I do not know that the hydraulic jump will effectively remove this condition. I do know, however, that an examination of the hollow concrete dam having sloping face both at the heel and to the toe, a similar dam having a clear overfall and a dam of the solid type having a sloping surface to the toe and pool have all shown the same characteristics in this vicinity, cutting out in one case solid rock to the depth of about one-quarter of the height at the toe. In two of the cases mentioned, the water was flowing over the dam, which had a smooth rounded crest, and in the other case the crest of the dam was as shown on p. 275 of the paper mentioned herein.

Towson, Md., Jan. 31, 1928.

A. E. WALDEN,
Chief Engineer.

Some Difficulties in Pole Testing

Sir—In the article entitled "Maximum Load for Treated Poles Measured in Test Series" in your issue of Jan. 9, p. 108, it is stated, "The testing methods and principles followed were those developed by the U. S. Forest Service." Use by the Pacific Telephone & Telegraph Company of the method described antedated its use by the Forest Service. With the exception of one series, pole tests by the Forest Service have been made in a testing machine, the poles being supported near the butt and tip and loaded at a point corresponding to the ground line. (Only 25-ft. poles have been tested in this manner.) This is sometimes referred to as the "beam method," whereas that described in your article is commonly called the "cantilever method." In order to get a comparison between the two methods of test, the Forest Service applied them to groups of similar poles in the one series mentioned above. This comparison indicated that there is no essential difference between the two methods, a conclusion that is supported by theoretical analysis of the problem.

A much more important consideration in connection with tests of poles is that the poles be in a condition similar to that which obtains in service. It is generally conceded that in most settings poles are subject to sufficient absorption of moisture in the vicinity of the ground to make their strength no greater than that of green or soaked material. Also it is well known that the strength of wood is increased by drying. Unless this increase is offset by some circumstance or factor such as defects either produced or increased in the process of drying, a seasoned pole is stronger than one that is wet or green.

The report upon which your article appears to be based shows that the poles tested were treated under a specification which requires that before injection of preservative they be seasoned to a moisture content not exceeding 20 per cent in the outer 2 in. No moisture determinations are mentioned in connection with the strength tests. If the seasoning specification was followed and the outer 2 in. reduced to an average moisture content of 20 per cent or less, the outer surface would be at a moisture content considerably below this average. Additional drying probably took place before the tests were made. Such seasoning might very appreciably increase the strength above that of green poles. On the other hand, there is some evidence that because of progressive failures (in compression) of outer layers of varying degrees of dryness a partly dry pole of some species may show a lower strength than if green. Which of these two effects obtained in the tests of treated Douglas fir poles it is impossible to state, although the results quoted would

seem to indicate that they were increased rather than decreased in strength by seasoning.

Near the end of the article referred to a comparison is set up between the test results presented in it and certain values quoted from a report by the undersigned. Those values, 7,300 and 6,300 lb. per sq.in. for dense and non-dense Douglas fir, respectively, were suggested in this latter report as a basis for pole design. They were based principally on data from tests on small clear green specimens and were set considerably below average values to take care at least partly of the variability in the strength of wood.

A further factor affects comparisons of the data quoted. Tests have shown that the form of the cross-section of a wooden beam greatly affects values of modulus of rupture. It has been found, for instance, that beams of I-section may yield modulus of rupture values as much as 30 per cent below those for rectangular beams of the same depth. Similar tests show about 15 per cent higher values of modulus of rupture from tests of round than from tests of square beams.

Presumably, the reader of the article is expected to draw conclusions from the figures quoted. It is doubtful whether any conclusion whatsoever is justified.

The Douglas fir poles are designated as "dense, having more than six annual growth rings per inch." The requirement of a definite proportion of summerwood is the more essential part of the definition of density as applied in the grading of structural timbers of Douglas fir or Southern pine, or as suggested for application to poles in the report referred to in the article. The presence of six or more rings per inch does not assure that the poles should be classed as dense.

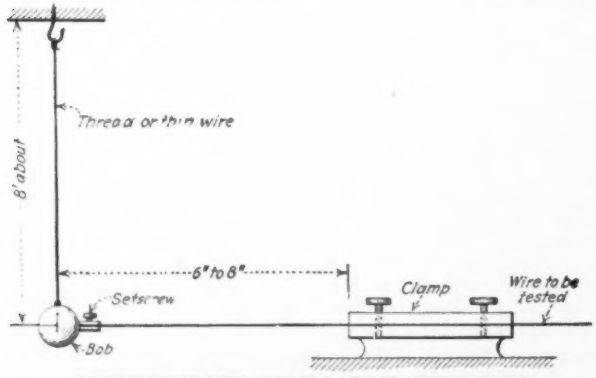
It is unfortunate that in all or nearly all the numerous series of pole tests that have been made by various agencies, including the U. S. Forest Service, partly or fully seasoned poles have been used. No one knows how to adjust the resulting data for the effect of seasoning, and without such adjustment they are of little value for determining the effect of preservative treatment, for comparing species or for estimating what loads can be carried by poles in service.

Madison, Wis., Feb. 16, 1928. THOMAS R. C. WILSON, Engineer, Forest Products Laboratory.

Calibrating Wires for a Mechanical Analysis System

Sir—In the article, "Brass Wire Models Used to Solve Indeterminate Structures," Dec. 8, 1927, p. 920, an apparatus is described for calibrating the wire rods for the models. The apparatus here described is submitted as being very simple to use and as providing even better results than the one described in the article mentioned. In the accompanying drawing the rod to be tested is held in a clamp near one end, and is caught in a heavy bob by a set screw at the other end. The length of rod between the clamp and the bob is kept constant for all rods tested. The bob is supported by a vertical thread or thin wire as shown.

To operate the apparatus, let the bob swing freely through a small arc, and count the number of swings made in a minute, n_p. Then attach the rod to the bob and determine the new number of swings, n. With E = modulus of elasticity and I = the moment of inertia of the rods, the flexural rigidity, or EI, is proportional to $n^2 - n_p^2$. Since n_p may be determined once and for all, it is only necessary to observe the number of vibrations per minute for each rod in order to find the relative flexural rigidities.



APPARATUS FOR CALIBRATING WIRE RODS

Princeton, N. J., Jan. 28, 1928. THEODORE E. STERN.

Mark Twain on Regulating the Mississippi

Sir—Articles appearing in *Engineering News-Record* during the past few months bring to mind portions of Mark Twain's "Life on the Mississippi," particularly pertinent being Uncle Mumford's impressions. He says, in part:

"As long as I have been mate of a steamboat—30 years—I have watched this river and studied it. Four years at West Point and plenty of books and schooling will learn a man a good deal, I reckon, but it won't learn him the river. . . . This ain't that kind of a river. . . . They are going to take this whole Mississippi, and twist it around and make it run several miles up stream. Well, you've got to admire men that deal in ideas of that size and can tote them around without crutches; but you havn't got to believe they can *do* such miracles, have you? And yet you ain't absolutely obliged to believe they can't."

Some 50 years have passed since "Uncle Mumford" straddled this question of river improvement and the work done during this long time has not entirely regulated the river nor has the experience brought forth a generally approved plan for accomplishing this purpose. Will his stand be safe for another half-century?

A reading of the book gives those of us lacking first-hand experience with this mighty river some slight conception of the problem of regulation, and gives it more vividly, perhaps, than writings more often found in an engineer's library. This statement is most illuminating: "Nearly the whole of that 1,300 miles of old Mississippi River which LaSalle floated down in his canoes 200 years ago is good solid dry ground now."

Katonah, N. Y., Feb. 9, 1928. T. DEL. COFFIN.

Earthquakes and the Column Deflection Method for Designing Lateral Bracing

Sir—We have been much interested in the article appearing in *Engineering News-Record* Jan. 19, 1928, p. 106, on the column deflection method for designing lateral bracing, by Messrs. Van der Mey and Spitzer, of San Francisco. Such studies are well worth earnest consideration by those interested in designing buildings properly to withstand horizontal forces.

There is, however, one important phase of the problem that is unmentioned by the authors. Where earthquake shocks are to be regarded, the force must be considered as applied in any direction. Obviously, in a rectangular structure, one system of girders receives its maximum stresses when the direction of the applied force is parallel and while the other system is idle. In a design similar to the example used, the maximum stresses in the columns, however, occur when both girder systems are partly stressed, due to a force of equal magnitude applied on a diagonal. For a column with different properties about its two axes, the direction of force producing maximum stress can be determined mathematically. For groups of columns of varying lengths and unsymmetrical section, the mathematical solution becomes involved.

The object in writing this letter is to guard those who might accept the method outlined as being a complete analysis of the stresses in the columns of a building subject to earthquake shock.

New York City, Feb. 10, 1928. JOHN W. PICKWORTH, Weiskopf & Pickworth, Consulting Engineers.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Technical Men Seek Equal Distribution Of Salary Increase

Will Go to City Hall on March 8 to Present Their Grievances to the Mayor

AT A LARGELY attended meeting of the technical men in the employ of New York City, held at the Labor Temple, Feb. 20, favoritism and politics were charged to the Mayor and to the Director of the Budget in the proposed distribution of salary increases. It was unanimously decided that on March 8 at 12 o'clock noon all of the 3,600 city technical men would assemble at the City Hall and demonstrate to the Mayor and the Board of Estimate their protest and their demand for immediate action.

Last October the Board of Estimate and Apportionment voted $600,000 to increase the salaries of technical men employed by the city. Much indignation has developed among the technical men against the reported method of distribution of these increases, as it is believed that those favored by the politicians are scheduled to receive the lion's share and that the increases are to be made in an inequitable manner. There is also much indignation in the delay in putting the increases into effect.

The meeting on Feb. 20 was held under the auspices of the Union of Technical Men, Local 37, Dudley P. Babcock, president, and it was voted to elect a committee to present the demands to the Mayor on March 8. It was also decided to invite representatives of the engineering societies to participate on this committee. Last October George T. Seabury, secretary of the American Society of Civil Engineers, pursuant to the action of the board of direction of the society, wrote a letter to the Board of Estimate expressing the hope that the board would adjust salaries in accordance with the schedules prepared by the chief examiner of the Municipal Civil Service Commission. This report recommended an increase in salaries amounting to about 35 per cent.

Two resolutions were adopted by the meeting on Feb. 20. One related to the salaries of technical men employed by the city in general and was as follows:

Resolved:

1. That we call upon Mayor Walker to instruct the Budget Director to report without further delay on the distribution of the $600,000 set aside by the Board of Estimate and Apportionment last October for increases to the technical employees.
2. We believe that the only equitable method of increasing the salaries at the present time is by flat percentage increase to all employees.
3. We demand that grades be raised so that those at the top of the grade can receive the same percentage increase as the other men.
4. That increases shall be retroactive and effective as of Jan. 1, 1928.
5. We are emphatically opposed to lump sum increases for individuals, and to different percentage of increases for the various grades and groups. We ask that no favoritism or discrimination be shown, but that all the engineering service be included and be treated alike.
6. *Be It Further Resolved* that copies of this resolution be sent to the Board of Estimate and Apportionment, the Mayor and the Budget Director, and that the officers of the Union of Technical Men, Local 37, together with representatives of the Central Trades and Labor Council, be requested to wait upon the Budget Director and the Mayor to place our demands and views before them.

The other resolution specifically related to technical men employed by the Board of Transportation and was of like tenor, but called for action by that board.

First Train Is Run Through Moffat Tunnel

The formal opening of the Moffat Tunnel took place on Feb. 26, when the first train, carrying 2,500 citizens of Colorado and Utah, passed through. The trip through the tunnel was made in twelve minutes. Before the construction of the tunnel trains wound upward over Corona Pass and took seven hours to make the trip.

The tunnel shortens the Moffat line 23 miles between Denver and Craig, Colo., the present terminal. It eliminates all 4 per cent grades over the Continental Divide and makes the maximum grade 2 per cent. Construction of a cutoff 42 miles long to connect with the Denver & Rio Grande Western Railway at Dotsero would reduce the distance beween Denver and Salt Lake City by 172 miles. There are no definite plant for its construction.

Union of Technical Men Urges Work for Unemployed

The Union of Technical Men, Local 37, New York City, has sent a resolution to the Mayor and the Board of Estimate outlining how, in its opinion, immediate relief can be given to the many unemployed. Among projects work on which, the union says, could be started by the city are mentioned the following:

Proposed civic center around City Hall, improvement of Central Park and Riverside Drive, street paving and highway construction, sewer and highway construction in Queens, West Side elevated driveway, sewage disposal plant on Ward's Island, Tri-Boro bridge, water-supply tunnel through the Bronx and Queens, improvements at docks, and building of new schools.

Both Captains Are Blamed for Sinking Submarine "S-4"

Naval Court Recommends Technical Board to Study Safety and Salvage Equipment

A NAVAL court of inquiry which investigated the sinking of the submarine "S-4" by a coast guard destroyer off Provincetown, Mass., on Dec. 17, 1927, has reported findings that place the responsibility for the collision on the commanding officers of both vessels. The commanding officer of the "S-4," Lieut.-Commander R. K. Jones, was lost, together with 39 others.

Among the court's recommendations are that trial courses used by submarines be indicated on charts on buoy lists; that the Navy omit from its pilot charts the statement now appearing thereon, to the effect that submarine trials will be indicated by warning flags displayed by an accompanying tender; and that a technical board be appointed to study the subject of rescue and salvage fittings, safety devices and equipment for submarines, tenders and rescue vessels.

The "S-4" was struck by the destroyer "Paulding" while engaged in a standardization trial on a long-used trial course near Provincetown. It had made several runs fully submerged, and after completing a run at "periscope depth"—that is, with deck about 20 ft. below water and both periscopes raised to several feet above the surface—was just coming to the surface. The sea was choppy and a stiff wind was blowing. The "Paulding" at this time rounded in toward Provincetown after a service cruise outside the cape and after one or two changes of course crossed the course of the "S-4" at a speed of eighteen knots without sighting the periscopes until within 200 or 300 ft., at which time the submarine was coming to the surface and lowing its periscopes. The submarine also did not sight the destroyer coming toward it until within eleven to twelve seconds before the collision, the court concludes. It was then impossible to avoid a collision. The submarine went down in about 100 ft. of water.

The court found by trials with sister vessels that the "Paulding" should have been able to sight the periscopes and their wake at 2,000 yd. or more, but that its lookout was inefficient and the submarine was not sighted until within 75 yd.; and that the "S-4" should have sighted the "Paulding" and cleared it.

As to the rescue and salvage operations, which were continued respectively about

(*Continued on p. 372, col. 2*)

Recovery for "Norman" Victims' Heirs Insured In Bill Before Congress

Growing out of the "Norman" boat disaster May 8, 1925, when 23 engineers and their friends were drowned in the Mississippi River below Memphis, was an act of Congress passed July 3, 1926, permitting the widows and estates of deceased engineers to sue for damages. The courts held that the act opened the door to an empty room in that it did not grant the right to sue for an action in tort, and that as a sovereign the United States is not responsible for negligence or acts of its officers.

Since it would plainly appear that Congress intended to make recovery possible, amendments to that end legally have been presented to both houses, Senate Bill 851 and an identical House bill, 6473. Both amending bills were referred to judiciary committees and the Senate committee has reported it out favorably. The House bill is still in committee, being in the hands of I. G. Hersey, chairman of a sub-committee.

This amendment states that "suits for damages grounded in tort are expressly allowed." The total amount recoverable is set at not to exceed $15,000 and claimants "shall only be required to prove that they are the proper legal parties entitled to the recovery sought."

This last clause was inserted to preclude necessity of proving negligence and blame, since an inquiry of an official board of five engineers had already heard testimony, gathered all information available and rendered a report on responsibility and negligence. (See *Engineering News-Record* Sept. 3, 1925, p. 387.) It is contended that this board should be considered far more competent than any ordinary jury. Many widows of those lost are not able to bear the necessary cost of a long suit, which could only rehearse what this board has already established.

Metcalf, Metcalf & Apperson are the attorneys in Memphis handling most of the suits filed, ten death claims and two personal injury claims. Senator K. D. McKellar and Congressman Herbert Fisher are sponsoring the amendment.

Building Code Limiting Apartment House Heights Upheld

The provisions of a supplement (June 10, 1924) to the building code of Montclair, N. J., limiting to three stories all buildings constructed or altered for use as apartments to house more than six families have been upheld by a decision of the New Jersey Supreme Court (rendered Jan. 5 and filed Feb. 6, 1928; Harrison R. Vandyne, Inc., *vs.* William H. Senior, building inspector, and Town of Montclair). The decision supports the contention of the town that the proposed apartment house would still further overburden an already overcharged sewer for which the town is actively planning relief.

The corporation just named, having been denied a building permit for an eight-story building to house thirty-four families, applied for a writ of mandamus. The town made a reply in which several questions of fact were raised and these issues were referred to a jury. The main issue and the ruling based upon it is thus stated in the decision:

One of the issues of fact raised by the return to the alternative writ was that the supplement to the building code was made necessary and its reasonableness was justified by a sewage condition which the Town of Montclair was making every effort to remedy and which would require some two or three years to accomplish and that until accomplished the sewage facilities of the municipality were and would be highly inadequate and a menace to the health and safety of its inhabitants. Upon the trial at Circuit this fact was found and established in favor of respondent, Town of Montclair. We must conclude, therefore, that the provisions of the supplement to the Building Code are reasonable and rest upon a substantial necessity. This seems to us to be dispositive of the application before us and the peremptory writ of mandamus is refused and respondent may enter judgment in its favor under the alternative writ.

Both Captains Blamed for Sinking Submarine "S-4"

(*Continued from p. 371, col. 3*)

five days and two weeks, the court says that they "were logical, sound and the most promising of early success." It also states that "no known devices not employed in the rescue operations, either in the Navy or owned by commercial organizations, could have saved the lives on board the 'S-4,'" and "under the weather conditions that existed rescue was beyond human power."

It finds that the personnel of the submarine was from some undetermined cause driven from the central operating compartment very shortly after the collision, and thereby was deprived of the use of the ship's facilities for aiding in their rescue.

Thirty-two bodies were found in the engine and motor rooms; the air here available could support life for only 25 hours. Six are believed to be in the torpedo room, where the available air would have supported life for 65 to 72 hours. Two are missing. If soda lime for absorbing carbon dioxide had been available and used, it "would not have saved any life, but might have prolonged the life of some for a few hours."

The findings also state that Rear-Admiral Brumby, in command of submarines in the Atlantic and in command of the rescue operations, "had not the familiarity with the essential details of construction of submarines and the knowledge of rescue vessels and the knowledge of the actual work being carried on by his subordinates necessary to direct intelligently the important operations of which he was in charge." He "failed to contribute that superior and intelligent guidance, force and sound judgment expected from an officer of his length of service, experience and position."

Model Traffic Ordinance for City Use Drafted by Highway Safety Committee

Progress on proposals for harmonizing automobile driving rules and practices throughout the country was made when a committee of the National Conference on Street and Highway Safety completed a draft of a model municipal traffic ordinance meeting in the offices of the U. S. Chamber of Commerce in New York on Feb. 17. This model ordinance will be printed and sent out to police departments, traffic engineers and interested organizations in all cities and towns throughout the country. Criticisms and suggestions will be invited and the ordinance will be further revised in the light of these suggestions.

The committee, which was appointed by Secretary of Commerce Hoover last July, is headed by William E. Metzger of Detroit and includes police officials, traffic judges, traffic and safety engineers, representatives of motor clubs, railroads, street railways, safety councils, chambers of commerce and other interests concerned with the traffic problem. Arthur A. Thomas, chairman of the legislative committee of the Providence City Council, is chairman of the drafting committee. Members of the committee had met previously at Detroit, Chicago and Washington, having before them a digest of the existing ordinances of more than 100 municipalities.

This work is being done in response to a widespread demand for a model form of ordinance available to various cities and towns in connection with any revisions of their existing ordinances and regulations. It is in harmony with the uniform vehicle code recommended by the National Conference as the basis for state motor-vehicle laws and now adopted and in effect in approximately half of the states. The model ordinance is designed to supplement the state law, applying it to the situation in the cities and towns and adding appropriate provisions to meet urban conditions.

Bill to Select Device to Prevent Grade Crossing Accidents

A bill introduced in the House by Representative Newton of Minnesota proposes the appointment of a board of engineers to select the most practical device for the prevention of grade crossing accidents and to supervise its testing and installation. This board is to have five members, two appointed by the interstate commerce committee of the Senate and the remaining three by the interstate and foreign commerce committee of the House.

The bill provides that after the most practical appliance has been selected and tested the board shall supervise its installation on the railroads, requiring them to install a certain percentage of their total mileage each year and imposing fines in cases of delay or failure.

Washington Notes

Pressure Is Exerted for Early Action on Flood-Control Bill; Tennessee River Power Report

By Paul Wooton
Washington Correspondent

UNDER pressure from the White House and from the Mississippi Valley every effort is being made to speed up the consideration of flood-control legislation. In an effort to do his part toward expediting the matter the President has let it be known that he will not oppose the payment of the entire cost of construction if the project is confined to the lower Mississippi River and to the lower tributaries in so far as they are affected by the flood waters of the main river. He is very anxious, however, to guard against a precedent which would make the federal government responsible to an equal degree on other streams.

The administration has insisted throughout that any legislation which may be enacted should point out that the situation on the Mississippi is in a class by itself. The effort to draw Secretary Hoover into a break with his chief over flood-control matters was unsuccessful. He refused to be drawn into criticism of his colleagues in the government. In the course of his testimony he expressed very positive views as to the advisability of vesting executive authority in the hands of one man. In reply to questions in regard to the lack of civilian participation in the formulation of the Jadwin report Secretary Hoover said the problem is not whether the work should be done by civilian engineers in the Army or out of the Army. The need of the situation is to secure the most effective men. He pointed out that there have been few opportunities for civilian engineers to acquire experience in the type of river work involved.

Government Contract Work

Early consideration of the Campbell competitive-contract bill is expected in the House of Representatives. In its report to the House the judiciary committee points out that the answers to questionnaires sent to state highway and city engineers disclose that 89.7 per cent of the entire amount expended for public and private construction is on the basis of the competitive-contract system, leaving but 10.3 per cent done by day labor. It is the opinion of the committee "that the American people desire the government to do as little as possible of this work and as much as possible should be done by private concerns and individuals. We believe the enactment of this legislation will retard and prevent encroachment on the part of governmental agencies and lessen the disposition to encourage day-labor construction in competition with private concerns and corporations. The construction of public works in the United States approximates $2,000,000,000 annually. This sum will increase rather than decrease. The soundest and most economic system should be employed. The enactment of this legislation is a guaranty of the best and most economic plan to follow." The bill is strongly opposed.

A New Flood-Control Bill

On Capitol Hill sentiment is swinging to a new bill introduced by Senator Jones, chairman of the commerce committee. This bill adopts the Jadwin plan as the basis for legislation, but creates a board to determine broad policies. The board is to be composed of the Chief of Engineers, the president of the Mississippi River Commission and an eminent civilian engineer. Execution of the work would be under the immediate direction of the Mississippi River Commission, but the commission would be made directly responsible to the Chief of Engineers and the Secretary of War. Local contributions would be confined to one-third of the cost of bringing all levees to the commission's 1914 grade and cross-section. The local interests in addition are required to furnish rights-of-way and to maintain the flood-control works after they are built. Before the bill emerges from the committee it is expected to be amended in important particulars.

Tennessee River Power

In connection with the exhaustive survey being made of the Tennessee Valley the Chief of Engineers has submitted to Congress the final report on the Tennessee, Clinch and Powell rivers, and a progress report on the remaining portions of the study. The cost of the Cove Creek dam is estimated at $37,540,000. If it is built it should be tied in with the Clinton, Melton Hill, and Kingston dams, the report says, which will cost an additional $24,900,000. When property damages are added the entire project would cost $86,016,000. To develop the maximum power resources of the river, the report says, nine dams should be built between Knoxville and Colbert Shoals. Dam No. 3 at Muscle Shoals would be one of the nine. The cost of the full development of the power resources of the entire valley along with navigation and flood-controls works will involve a cost of $1,000,000,000, the report states.

Agricultural Engineers Organize

Stanley F. Morse, consulting agricultural engineer, of South Carolina and New York, has been appointed chairman of the newly organized Division of Consulting Agricultural Engineers of the American Society of Agricultural Engineers. The purpose of this division is to bring together in one organization the most competent men in this profession. The qualifications of applicants will be examined and only those of proper training, experience and reliability will be admitted to membership, it is announced.

Brief News

To Encourage Scientific Research in connection with industrial problems, the Canadian House of Commons voted unanimously on Feb. 13 to appropriate $750,000 for the establishment of a national research council laboratory at Ottawa. The plan in its entirety will require an expenditure of $3,000,000 spread over a period of five to ten years. A site of ten acres for the first unit has already been chosen.

To Fill the Vacancy caused by the death of the late Clarence A. Crane, the General Contractors Association of New York City has elected Edward L. Stanton general manager. Mr. Stanton, at the time of this appointment, was secretary to James J. Walker, Mayor of New York.

Two Bills Have Been Introduced into the New York State Senate for the incorporation of toll-bridge companies. Senate Bill 491 would incorporate the Thousand Islands International Bridge Corporation to build and operate a bridge from near Collins Landing, N. Y., to some suitable and convenient point on Wells Island, thence to Hill Island and over the western channel of the St. Lawrence to Ontario, Canada. Senate Bill 532 would incorporate the Cataract Bridge Corporation to build and operate a bridge from Niagara Falls, N. Y., to Niagara Falls, Ont.

Work on the 600-Ft. Drydock at Port Weller on the Welland ship canal will begin at an early date, according to Alexander J. Grant, engineer in charge. Mr. Grant believes that the canal will be completed in 1930 and be ready for the opening of navigation by the spring of 1931. Several contractors have continued their work all winter, and all are preparing for a start in March. It is expected that 3,000 men will be employed on the job this year. The cost of the canal up to Dec. 31, 1927, was $87,465,040.

The Summer School for engineering teachers, established last year by the Society for the Promotion of Engineering Education, will continue its sessions next summer. Two schools will be held, one at the Massachusetts Institute of Technology for teachers of physics and one at Pittsburgh, under the auspices of the University of Pittsburgh and the Westinghouse company, for teachers of electrical engineering. Both sessions will begin shortly after July 4 and will last three weeks. There is a nominal charge of $10 as a registration fee.

Municipal Problems will be taken up at the annual meeting of the Maryland Water and Sewerage Association, to be held in Baltimore on April 10 and 11. These will include municipal ownership of water supply, garbage and refuse disposal, water system maintenance problems and stream pollution prevention.

Supreme Court Rules Interstate Bus Tax Not Discriminatory

In a decision handed down on Feb. 20, the United States Supreme Court upheld the right of the State of Connecticut to impose a tax of 1c. for each mile of highway transversed by buses engaged in interstate commerce. The Interstate Bus Corporation, which operates buses between Connecticut, Rhode Island and Massachusetts points, had sought in the lower courts to enjoin the State Tax Commissioner from collecting this tax, protesting that it is discriminatory and therefore unconstitutional. The ruling of the District Court refusing to grant this relief to the bus company is now upheld by the Supreme Court.

Justice Stone, who handed down the opinion in this case, expressed himself as follows regarding the contention that the bus company already contributed toward highway maintenance in its regular taxes: "That appellant is already contributing to highway maintenance is not in itself significant, because the state does not excede its constitutional authority in imposing more than one form of tax as a charge for the use of its highways in interstate commerce. It is for the appellant to show that the aggregate charge bears no reasonable relation to the privilege granted."

In concluding, Justice Stone said: "But we need not consider here whether the principle relied upon goes so far as to prevent the state from excluding from its highways a motor carrier which refuses to pay charges for their use." The fact that motor buses operating in intrastate commerce in Connecticut were exempted from this tax and paid instead a gross receipts tax does not alter the case, in the opinion of the court.

Wood Block Viaduct Paving Buckles in Cold Weather

Heavy rains followed by freezing weather proved disastrous for the wood block paving on the 1800-ft. steel viaduct at Riverside Drive and 125th St., New York City. For practically the entire length of the bridge the pavement buckled. The water which froze and expanded is believed to have entered both the cracks between the blocks and the blocks themselves. The roadway consists of 3-in. wood blocks on a concrete base poured on a steel plate bed. It is 60 ft. wide divided by steel angles into four 15-ft. longitudinal panels, and these are divided transversely every 31 ft. The buckling followed the center line of the traffic lane panels. On the west side of the viaduct the curb had been removed prior to raising the sidewalk and this traffic line, being unconfined on one side, was permitted to expand without buckling. Some of the blocks had originally been laid in mastic and others merely laid dry and covered with the jointing material. No superiority in resistance to buckling was noticed for one type of construction over the other.

It is believed that perhaps the panels are too large (15x30 ft.) since a reduction in the panels on the Queensboro Bridge across the East River has eliminated trouble from buckling on that structure. The 125th St. viaduct was closed to traffic for two days while the wood block was being relaid.

Railroad Consolidation Plans May Violate Anti-Trust Law

As a check upon the plans of L. F. Loree and his associates for the consolidation of the Kansas City Southern Railway, the Missouri-Kansas-Texas Railroad and the St. Louis Southwestern Railway into one system, the Interstate Commerce Commission has called upon the Kansas City Southern to show cause on April 2 why an order should not be entered for the dissolution of the combination as being in violation of the Clayton anti-trust act. The Kansas City Southern has acquired a considerable portion of the stock of the Missouri-Kansas-Texas in anticipation of approval of its plans for the proposed consolidation. In August, 1926, it applied to the commission for approval of the proposed grouping of the three railroads into one system, but at that time the commission declined to approve on the ground that the corporate set-up was not a proper one. In rendering its decision the commission stated that it considered that the acquisition of stock of a competing line before its approval had been granted might be in violation of the anti-trust law.

Pennsylvania Railroad Plans Improvements at Baltimore

The Pennsylvania Railroad is making plans for improvements at Baltimore, Md., which are estimated to cost $20,000,000, according to statements made by officials of the company at a dinner given in Baltimore on Feb. 23.

Plans made public by W. W. Atterbury, president, and Elisha Lee, first vice-president, call for the construction of an additional tunnel paralleling the present union tunnel; construction of another tunnel paralleling the Baltimore and Potomac tunnel; elimination of four grade crossings; completion of four tracks from Fulton Junction to Loudon Park, and other improvements.

The proposed changes are subject to approval by the city officials and by the Public Service Commission.

International Road Congress May Be Held in the United States

Under a resolution passed by the Senate on Feb. 24, President Coolidge was asked in invite the International Association of Road Congresses, with a present membership of 45 nations, to hold its sixth convention in the United States either in 1929 or 1930. At the same time the Senate passed a resolution calling for American participation in the second Pan-American Conference on Highways to be held in Rio de Janeiro next July.

Electorate of Detroit To Vote on $30,000,000 Bond Issue for Sewers

The Detroit City Council has voted to submit a proposition for a $30,000,000 bond issue for sewer construction to the voters of Detroit at a special election April 2. The bond issue represents a three-year sewer program as laid out by the Department of Public Works. An appropriation of $12,056,400 is asked for this year, $8,800,000 is to be spent next year and the remaining $10,000,000 in 1930. Most of the extensions are proposed for the Northwest section, annexed about three years ago and which is still practically without sewers.

It is understood that if the legislation now proposed in New York or Michigan affords relief from present bond limitations, the construction can be proceeded with. In event the legislative relief is not obtained in the near future, the bonds, if authorized by the people, would remain unsold until bond relief was obtained or sold only as the 7 per cent bond limitation would permit. The controller reported to the council that unless there is a substantial increase in assessed valuations, it would be unwise to offer for sale city bonds in excess of those already authorized.

Early Decision Possible in Chicago Water Diversion Suit

In a brief filed in the United States Supreme Court on Feb. 28 it is argued that the states combined against Illinois and the Chicago Sanitary District have failed in every aspect to justify their plea for an injunction prohibiting the further diversion of Lake Michigan waters at Chicago. Oral arguments in the case are to be heard by the court on a date in April yet to be fixed, and there is a possibility that the court will announce its decision before the summer recess.

Co-operation Among Builders Is Stressed at Miami Meeting

The chief problem confronting the construction industry at present, said Truman Morgan, president of the F. W. Dodge Corporation, of New York, at the annual meeting of the National Association of Builders' Exchanges, held in Miami, Fla., Feb. 6 to 9, is the closing of the gap in a satisfactory volume of business between little or no profit and a fair return on the investment. This can be done, he declared, by gathering in council, bridging competitive differences and jealousies and working harmoniously in the interests of common business. Another talk along the same lines was made by Gen. R. C. Marshall, Jr., of Washington, manager of the Associated General Contractors of America, whose subject was "Co-operation in the Building Industry."

All officers were re-elected and Youngstown, Ohio, was chosen as the place of meeting in 1929.

Personal Notes

THOMAS EARLE, WILLARD G. TRIEST and WOLFGANG G. TRIEST announce the formation of the general contracting firm of Triest & Earle, Inc., with offices in the Real Estate Trust Building, Philadelphia. Wolfgang G. Triest is president of the Triest Contracting Corporation, of New York, and Thomas Earle was formerly vice-president of the Bethlehem Steel Company.

JAMES F. CASE, formerly consulting engineer, Ulen & Company, has joined the firm of Stone & Webster, Inc., to take charge of an office which that company has opened in Paris, for the purpose of carrying on investigations of public utilities, valuations and similar work. Mr. Case has had a wide experience in this field, having reported on properties and projects in Italy, Spain, France, Mexico and Venezuela. While director of public works in the Philippine Islands from 1901 to 1910, he made exhaustive studies of the water-power possibilities of the islands, and in 1918-22 studied and reported on the principal hydro-electric properties in northern Italy. Recently he served on a technical committee of the League of Nations which reported upon the development of the navigable waters of Poland and upon the drainage of the marshes of Polesia.

NEVIN ELWELL FUNK has been appointed chief engineer of the Philadelphia Electric Company to succeed the late William C. L. Eglin. Mr. Funk had been assistant chief engineer since Dec. 15, 1926.

GEORGE S. HALLENBECK has severed his connection as manager of the Buffalo office of the Pittsburgh Testing Laboratory and announces the opening of the Hallenbeck Inspection and Testing Laboratory, for the general inspection and testing of materials, at 23½ West Seneca St., Buffalo, N. Y.

R. Y. STUART, of Carlisle, Pa., has been chosen to succeed William B. Greeley as chief of the U. S. Forest Service. Colonel Greeley will resign May 1 to become secretary-manager of the West Coast Lumber Manufacturers' Association.

ERNEST J. BEATTY, a graduate in sanitary engineering from the University of Iowa, recently was made assistant sanitary engineer of the Wisconsin State Board of Health. His major activities will be in assisting in the development of the state's stream pollution control program. Mr. Beatty was formerly employed by the Wisconsin Highway Commission.

Col. FRANK C. BOGGS, Corps of Engineers, in charge of river and harbor work in Philadelphia and vicinity, will be placed on the retired list of the army June 15, on his own application after more than 34 years' active service. He was graduated from the Military Academy in 1893 and during the World War commanded the 350th Engineers in France, and afterward was attached to the General Staff at the War Department until 1923, when he was transferred to Philadelphia.

L. SEGOE, secretary-engineer of the City Planning Commission of Cincinnati, Ohio, has resigned and the position has been temporarily filled by the appointment of Erwin A. Kreimer.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fourteen annual convention in El Paso, Tex., on June 4, 5 and 6.

THE DETROIT ENGINEERING SOCIETY, at its meeting on March 9, will hear a lecture, illustrated with slides, on "Stadiums, Ancient and Modern," by W. S. Hindman, designer of the Ohio State and University of Pittsburgh stadiums.

Obituary

JACOB SCHMITT, chief engineer of the Brooklyn (N. Y.) bureau of highways since 1921, died on Feb. 26 of a cerebral hemorrhage. After his graduation from the Brooklyn Polytechnic Institute in 1900, Mr. Schmitt joined the engineering staff of the New York Central Railroad and later that of the Rapid Transit Railroad Commission. He had been with the Brooklyn bureau of highways since 1903. He was a member of the American Society of Civil Engineers and the Brooklyn Engineers Club.

KIRBY L. STRICKLAND, division erecting manager of the American Bridge Company at the Chicago office, died on Dec. 10 at his home at Evanston, Ill., after an operation for appendicitis. He was born at Roscoe, Ga., in 1871, and in 1896 he entered the erecting department of the Edge Moor Bridge Works, which firm was later absorbed in the American Bridge Company. He was a member of the American Society of Civil Engineers and the Western Society of Engineers.

FRANK H. AVERY, engineer of bridge maintenance in the Department of Public Works, Chicago, was killed on Jan. 26 by the breaking of a swing cable on a dredge working in the Calumet River at South Halsted St. He had held this position for sixteen years and much of his responsible work was keeping in service some of the old and outworn bridges until funds and authority were available for reconstruction. This included placing new bottom chords and web members in the trusses of swing and fixed spans.

RICHARD A. BERRY, assistant engineer of the New York City Board of Transportation, died on Feb. 18 of pneumonia. Mr. Berry, who had been engaged in engineering and construction since 1899, was a graduate of Manhattan College and Fordham University. His service as assistant engineer with the Public Service Commission, the Transit Commission and the city Board of Transportation was mainly on the construction of the subway stations in the Bronx. His latest work was the construction of the inclosed passenger transfer connection between the elevated and subway lines at 149th St. and Third Ave., which accommodates 15,000 passengers an hour and eliminates use of transfer tickets.

Brig.-Gen. SAMUEL M. MANSFIELD, U.S.A., retired, for many years head of the New England district engineering work of the War Department, died at his home in Boston on Feb. 18. General Mansfield was graduated from West Point in 1862 and served with distinction in the Civil War. He was an expert engineer and was assigned to important engineering development by the War Department during the period of reconstruction. In 1885 and 1887 he was president of the commission appointed by the government to run and mark the disputed boundary lines between Indian Territory and Texas, and in 1898 and 1899 he was president of the California commission to regulate hydraulic mining. In 1899 he headed the Yosemite National Park Commission. In 1906, three years after his retirement from the army, Gov. Curtis Guild of Massachusetts appointed him chairman of the Harbor and Land Commission, his appointment being based on his experience as an engineer in charge of the defences of Boston and Massachusetts Bay during the Spanish War.

PETER R. HALEY, construction superintendent, George A. Fuller Company and an expert on tunnel building, died in Washington, D. C., on Feb. 17. Mr. Haley was born in Burlington, N. Y., and went to Washington in 1905 with the Jewell-Continental Construction Company, of New York, to superintend the building of the Southern Railway tunnel under New Jersey Ave. Southeast. As an independent contractor he later built the Baltimore sewage tunnel.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Brick Makers Urge Co-operation in Clay Products Field

Greater co-operation among the burned clay products industries through the medium of a national council of the ceramic industries, to be composed of the officers of the several associations, was urged at the convention, Feb. 13-17, of the Common Brick Manufacturers' Association by B. Mifflin Hood, Atlanta, Ga. Mr. Hood is a leading brick and tile manufacturer in the South. The plan he suggested was heartily approved.

Closer relationships and better understandings between the hollow tile and common brick industries, to the end that their differences may be amicably adjusted in conference rather than fought out in a keenly competitive way, was encouraged in a talk by T. W. Murphy, Nelsonville, Ohio, hollow tile manufacturer.

The progress being made in Detroit in the development of new uses for common brick and new ways of winning back lost ground from its competitors was discussed by Charles A. Bowen. Basement walls, soundproof partitions in office buildings, closer contact with bricklayers and architects and the introduction of skintled brickwork in residence construction were the features stressed.

The value of cost finding and the efficiency of the new system being offered through the association was discussed by W. Gardner Long, Boston, and E. E. Pilgrim, Chicago.

Final Plans for the Western Road and Equipment Exposition

The success of the All-Western Road Shows which have been held during the past few years in San Francisco, Calif., has resulted in the extension of the show this year to include an exposition of contracting machinery and equipment of all kinds. Also the 1928 exposition will be held in Los Angeles where the Central Manufacturing District has donated a 20-acre field. Here it is planned to make available to exhibitors 200,000 sq.ft. of tented area in addition to the field where actual working demonstrations can be carried on.

It is stated that during the week of the show, March 7-11, various conventions of contractors, highway officials, sand and gravel operators, etc., will meet in the auditorium on the exposition grounds. The site is about ten miles from the center of Los Angeles and is served by a steam railroad, electric lines, motor buses and paved roads. The ground is supplied with power lines, a spur railroad and other necessary appurtenances.

The exposition is supported and conducted by the Western Construction Equipment Distributors, Inc., comprising leading distributors of contracting equipment in eleven of the Western states. Arthur E. Welch, 807 Union League Building, Los Angeles, Calif., is secretary for the exposition.

Business Notes

H. M. DAVISON, who has been with the Hayward Company, New York City, for a number of years, the last seven as general manager of sales, is leaving that company. Mr. Davison's future plans have not yet been announced.

WILLIAM C. SHERWOOD, for the last 30 years manager of the New York branch, Hersey Manufacturing Company, has become assistant to the president and will make his headquarters at the main office of the company in Boston. WILLIAM B. CAMBRIDGE, who has been connected with the company for 24 years both in the factory at Boston and in the sales organization in New York, will succeed Mr. Sherwood in the management of this branch.

WALLACE L. CALDWELL, formerly president of the Kentucky Rock Asphalt Company and prior to that director of the department of roads and pavements, Pittsburgh Testing Laboratory, has been elected president, Alabama Rock Asphalt, Inc., Birmingham, Ala. J. H. CONZELMAN, for the past three years chief engineer, Natural Rock Asphalt Corporation, Louisville, Ky., has been appointed chief engineer of the same company. Alabama Rock Asphalt, Inc., has just completed a plant at Margerum, Ala.

DONALD M. RYERSON, vice-president and general manager, Joseph T. Ryerson & Son, Inc., has been elected chairman of the board of directors, succeeding his father, Edward L. Ryerson, Sr., who died Jan. 19, 1928. Edward L. Ryerson, Jr., vice-president in charge of plant operations and several sales divisions, succeeds his brother Donald Ryerson as vice-president and general manager. Everett D. Graff has been elected vice-president, effective Jan. 31, 1928. Mr. Graff joined the organization upon graduation from college in 1906. In 1916 he was made assistant to the vice-president in charge of purchases.

DIVISION OF SIMPLIFIED PRACTICE, Department of Commerce, announces that the standing committee on sand lime brick has reaffirmed the existing simplified practice schedule without change for the two calendar years 1928 and 1929. A survey conducted prior to the revision meeting indicated that the average degree of adherence to the recommendation was 77.6 per cent.

CHARLES E. STONE, since 1924 vice-president, Interstate Drop Forge Company, Milwaukee, has been elected president, succeeding C. R. Messinger, who is a member of the board of directors and president of the Chain Belt Company. Lamar S. Peregoy was elected vice-president. Mr. Stone had previously been associated with the Chain Belt Company as purchasing agent and assistant to the president.

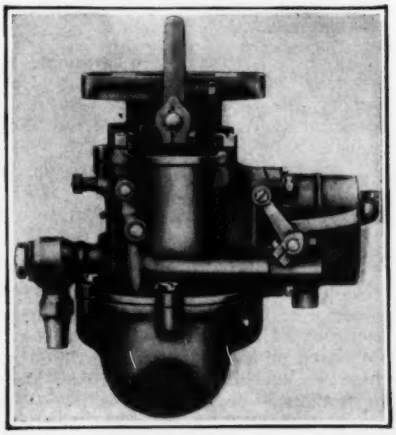
BATES VALVE BAG CORPORATION, Chicago, announces the building of a factory at Birmingham, Ala., in which will be manufactured the company's multiwall paper bags used for cement, plaster, lime, and other rock products. In the initial unit, which will be 60 ft. wide by 250 ft. long, one story in height, there also will be manufactured the company's filling machines, and wire ties used for closing cotton and jute bags and for reinforced-concrete construction.

HOWARD A. WINTON, of the Heil Company, Milwaukee, Wis., died on Feb. 7 after a week's illness with pneumonia. Mr. Winton had been with the Heil Company since 1919, holding positions as advertising manager, general branch manager and secretary of the Hydro Hoist Company, a subsidiary of the Heil Company.

New Developments

Carburetor Designed to Operate at 45 Deg. Angle

A new carburetor, series 70, has been designed by the Zenith-Detroit Corporation, Detroit, Michigan, for use on heavy-duty trucks and tractors. A feature of the new carburetor is that the position of the fuel bowl is centered so that tipping up to an angle of 45 deg. will not affect its operation. All air

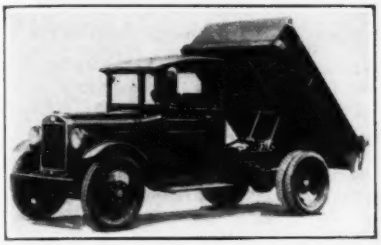


for the fuel bowl is taken through the air intake, thus permitting the use of air filters without enrichment of the mixture due to restriction of the air supply.

The carburetor is constructed to withstand the demands of most severe operating conditions. It contains an adjustment for the jet, but means for limiting its range is also provided. Thus the operator can adjust the mixture to meet any change in the conditions of operation without danger of going too far.

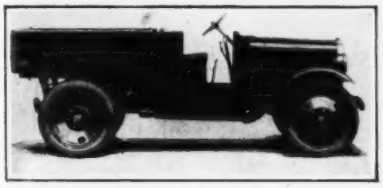
New 2-Ton Truck With Features for Road Building Work

Outstanding features of the new 2-ton road-builder truck built by Graham Brothers, Detroit, Mich., are a 6-cylinder engine, 4-speed transmission, with three optional rear axle ratios,



4-wheel Lockhed hydraulic internal brakes, 114-in. wheelbase and a frame 7⅛ in. deep. The rated speed is 35 m.p.h., and two standard dump bodies are offered—a gravity and a hydraulic type, both 1½ cu.yd. capacity and both shown in the accompanying illustrations.

The engine is basically the Dodge



Brothers Senior 6-cylinder, 3¼x4½ in. developing 45-50 b.hp. The 7-bearing crankshaft has a total main bearing length of 11 in. The forced feed oiling system delivers oil to all main, connecting rod and camshaft bearings as well as to the front end silent chain.

The 4-speed transmission has ball bearings on the main shaft and roller bearings on the camshaft. The transmission low ratio is 6.5:1. The frame is 7⅛ in. deep, ¼ in. material with a maximum flange width of 2⅞ in. Pneumatic tires are used throughout.

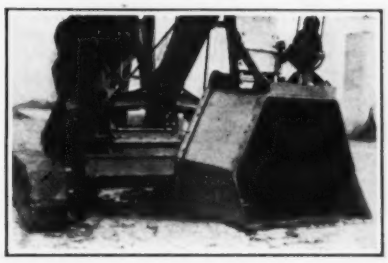
Motor Driven Centrifugal Pumps on Oil Pipe Line Service

An installation of motor driven centrifugal pumps was made in April, 1927, at the Coulter station of the Illinois Pipe Line Co. as an experiment to determine whether oil could be successfully handled at high pressure by centrifugal pumps and whether the churning motion of the pump blades would emulsify the oil. This installation, which is claimed to be the first of its kind, used two Westinghouse 150-hp. 1800 r.p.m. synchronous motors, driving two Cameron centrifugal pumps in series. After the tests, which were unusually satisfactory, it was decided to use pumps requiring 400-hp. 1800 r.p.m. synchronous motors. The normal pressures carried at the pumps is 500 lb. per square inch.

As a result of these tests the Illinois Pipe Line Co. has decided to electrify all of its lines from St. Louis to the Pennsylvania border, using 400-hp. Cameron pumping units. The motors are operated by magnetic push button starters and a pressure gage regulator panel is used, the gage operating to shut down the pump in case of a sudden rise or drop in oil pressure. Advantages in first cost and actual operating cost are claimed by the Westinghouse company for this method of pumping oil over that using steam and Diesel engine driven reciprocating pumps.

Special Bucket for Snow Loading

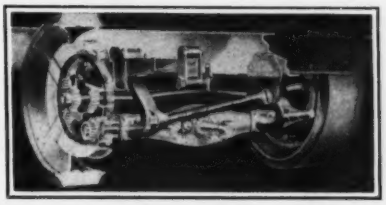
An over-size bucket of a shape particularly suited for handling snow in city streets, along curbs or gutters, has recently been developed by the Bay City Dredge Works, Bay City, Mich., avail-



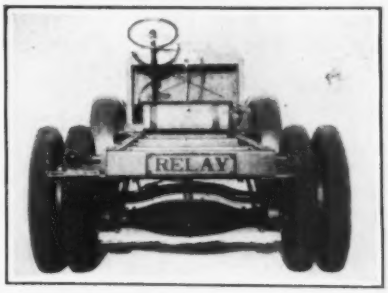
able as an extra bucket attachment to any Bay City tractor-shovel. The face of the bucket is 42 in. wide at the lip, tapering to 44 in. at the bottom so as to assure easy dumping of the packed snow. The capacity is 1 cu.yd.

New Truck Model Made in 1½-Ton Capacity

A new truck Model 30-A has been announced by the Relay Motors Corporation, Lima, Ohio, making available for the first time the Relay drive principle on a 1½ ton truck. The Relay drive principle, described in *Engineering News-Record*, January 6, 1926, provides



for a shifting of the rear axle forward and up in proportion to the pull required. The load which is supported by this drive axle necessarily moves forward and upward as the pinion on the end of the rear axle climbs the large circular track on the wheels. A phantom view of the truck's rear axle is shown in one of the accompanying illustrations. The other illustration shows a rear view of the 1½ ton model. The



new unit is powered by a six cylinder high compression type engine and uses four-speed transmission, four-wheel brakes and complete electrical equipment. Pneumatic tires are provided for the first time on a Relay drive truck.

Manufacturers and Trade Associations

Calendar

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual meeting, Biloxi, Miss., March 19-21.

SOUTHERN PINE ASSOCIATION, New Orleans; Annual meeting, New York City, March 26-28.

AMERICAN WATERWORKS MFGRS. ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

New Publications

Snow Removal—CATERPILLAR TRACTOR COMPANY, San Leandro, Calif., has published the 1928 edition of its snow-removal handbook, containing 65 pages of information with regard to the methods of snow removal now in use on rural highways and city streets. Some discussion is given to cost of snow removal work, while several sections of the book are directed to civic associations and city officials, stressing the importance of snow removal.

Steel Joists—GENFIRE STEEL COMPANY, Youngstown, Ohio, has just published a new booklet entitled "Steel Joists," which contains complete information, including loading tables on two new types of steel joist construction—the plate girder and the T-bar joists. The booklet contains 39 pages, and the drawings, descriptions and tabular matter are of such nature as to be of practical value to architects, contractors and engineers.

Business Side of Construction

Facts and Events That Affect Cost and Volume

A Record February; Seasonal Trends Are Contradicted

Commercial Buildings and Roads Exceed Last Month's Contracts and Those of February, 1927

CONTRACT awards for engineering construction reported by *Engineering News-Record* during February, 1928, amounted to $213,290,000, which is 8 per cent more than those of last month and 22 per cent more than those for February, 1927. This is the largest volume ever recorded for February, which was the lowest month of the year in 1925, 1926 and 1927.

Several classes of construction showed considerably larger totals in comparison with the totals of last month. Bridge contracts, which in February constituted about 5 per cent of the total, showed an increase of 123 per cent. Commercial buildings increased 71 per cent, mainly attributable to the Middle Atlantic States, which represented 57 per cent of the total for this class of construction. Street and road awards were 36 per cent larger than in January. An increase of 17 per cent was shown by water-works.

The Far West led in sectional advances with an increase of 22 per cent over last month. Street and road work in California increased 110 per cent, due to general improvement of highways and streets throughout the state. A $4,000,000 power plant increased the industrial building total more than 300 per cent. In Washington the total of $1,470,000 was the largest for any month since June, 1927. The Middle Atlantic increase of 17 per cent was due to greatly increased commercial building awards, about $50,000,000 in New York, compared with $25,000,000 a month ago. The volumes of street, road and bridge awards are noticeable influences in the 13 per cent increase in the Middle West. Increases in waterworks and all classes of buildings and a decrease in unclassified projects characterize the changes west of the Mississippi, where a net increase of 10 per cent was recorded.

Favorable changes in the volume of construction by classes in comparison with February, 1927, were shown by per cent increases as follows: streets and roads, 193; industrial buildings, 92; bridges, 86; commercial buildings, 66. Each section of the country showed larger volume of street and road building. The country west of Mississippi and in the Far West witnessed increased industrial buildings. The South and Middle West showed larger values for bridge work. The Middle Atlantic was the only section in which commercial building awards exceeded those of last year, the increase being $45,213,000.

Only two sections of the country showed construction activity to be ahead of last year. These were the Middle Atlantic, up 104 per cent, and west of the Mississippi up 15 per cent.

Projects reported by *Engineering News-Record* have minimum values for the several classes of construction as follows: commercial, educational, institutional and religious buildings, $150,000; industrial buildings, $40,000; sewers, bridges, streets and roads, and unclassified projects, $25,000; waterworks, excavation, drainage, irrigation, etc., $15,000.

During February there were 27 contract awards valued at a million dollars or more. The total value for these large projects was $75,026,726. The largest single contract was for a New York hotel estimated to cost $20,000,000.

General Business Irregular; Steel and Motors Active

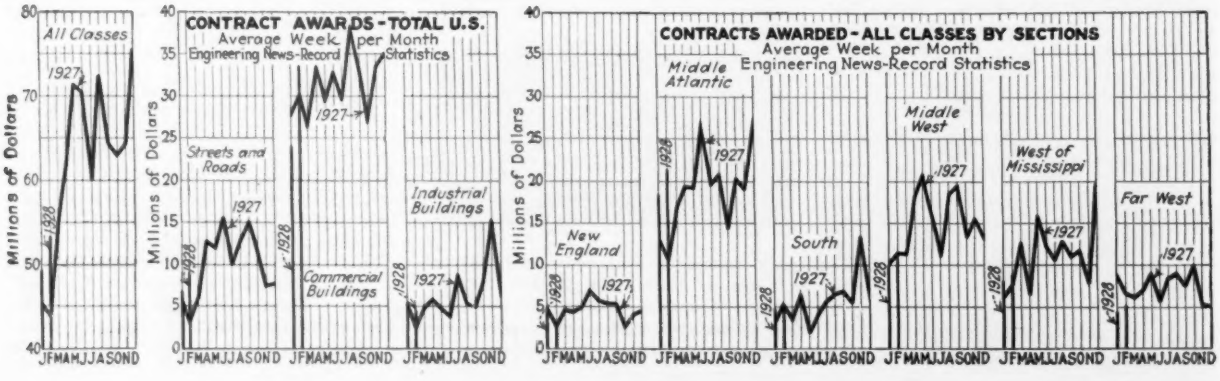
Economic factors in the greatly diversified sections of the country and in the numerous industries and trades cannot be consolidated and described in one concise statement of improvement or decline. General news shows great irregularity with considerable improvement in several important industries tending to offset unfavorable conditions in others. The charts at the bottom of this page show certain interesting movements.

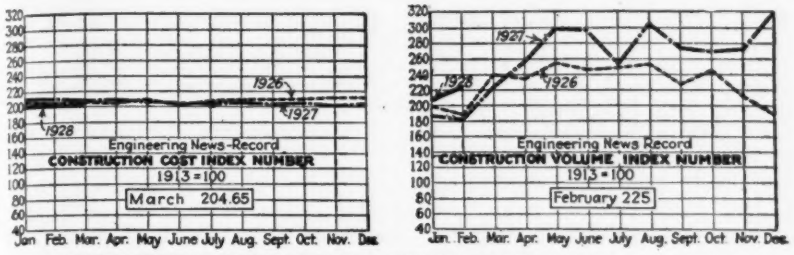
Extraordinary expansion in the steel industry is in part represented in the chart of ingot production. The increase in January was the greatest in several years. Sales of structural steel show a more than seasonal decline in January

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA—FEBRUARY, 1928

Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Waterworks	$53	$581	$569	$229	$1,083	.....	$2,515	$4,662	$24
Sewers	.....	193	436	547	379	$325	1,880	4,951	260
Bridges	318	1,719	2,153	5,078	932	206	10,406	15,067	.....
Excavations, drainage, etc	18	.....	219	110	195	85	627	3,606	.....
Streets and roads	1,424	3,024	8,214	10,399	8,486	4,699	36,246	63,027	.....
Industrial buildings	1,539	1,825	746	2,537	6,199	5,502	18,348	39,363	250
Commercial buildings	5,306	76,435	6,301	22,167	14,625	9,238	134,072	230,065	700
Federal government	10	58	119	41	64	37	329	5,944	.....
Unclassified	352	985	205	4,173	2,743	409	8,867	44,589	3,510
February, 1928	$9,020	$84,820	$18,962	$45,281	$34,706	$20,501	$213,290	.....	$4,744
January, 1928	17,340	72,804	19,077	40,280	31,681	16,802	197,984	.....	12,575
February, 1927	9,937	42,439	21,008	45,832	30,123	25,931	175,270	.....	3,594
Year to date, 1928	26,360	157,624	38,039	85,561	66,387	37,303	.....	411,274	17,319
Year to date, 1927	28,462	93,820	33,724	85,936	54,564	60,504	357,010	.....	18,622





ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

but the higher price for shapes is a favorable indication. Rate of production of ingots shows the U. S. Steel Corporation to be operating at 90 per cent capacity and independents at 80 per cent, a 7 per cent higher rate than last year for independents.

January production of automobiles showed an increase of 69 per cent over December, or 225,039 passenger cars and trucks. This is 6 per cent lower than January, 1927, production. The improved activity is reflected in passenger cars, fewer trucks having been manufactured than last month or a year ago. General Motors sales in January established a record for that month. Car registration figures for December (excluding Tennessee) show that month to be the lowest for the year. Total passenger car registrations during 1927 were 2,600,200 cars—a decrease of 16 per cent from the preceding year. Detroit employment has increased 44,159 since Jan. 1, according to a report of the Employers' Association.

Two of the usual indicators of general trade activity are quite contradictory. Bank debits for January, 1928, and three weeks of February are well above last year. Total debits for January were 62.89 billion dollars. January freight car loadings are lower than 1927 and 1926. The weeks of Feb. 4 and 11 are above 1926 but under last year.

Shipments of lumber (soft woods) during the first four weeks of 1928 show a complete recovery from the decline during the last four weeks of 1927 and are higher than in 1926 and 1927.

Cost Index Same as Month Ago; Volume Up 8 Per Cent

The *Engineering News-Record* Construction Cost Index Number for March is unchanged from the February level of 204.65. This indicates that nation-wide prices of materials and wages of construction laborers remain unaffected by present business trends. The tendency is toward a higher cost index for April, owing to increasing steel prices. Increased unemployment, on the other hand, may reduce the national level of wages, which tends to lower costs. Present costs are 2 per cent under those of a year ago.

Volume of February contract letting gained 8 per cent over January. This represents a net increase, since costs remained steady. The gain compared with February of last year amounted to 23 per cent. The Volume Index Number for February is 225.

E. N.-R. Cost Index		E. N.-R. Volume Index	
March, 1928	**204.65**	**February, 1928**	**225**
February, 1928	204.65	January, 1928	208
March, 1927	208.80	February, 1927	182
Peak, June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1913 (average)	100.00	1913	100
1927 (Cost)		1927 (Volume)	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319

Less Employment; Building Trades Normal

Estimates have it that 3,000,000 to 4,000,000 are unemployed in the United States at present. The American Federation of Labor states that the latter figure means that 40 per cent of the potential labor power of the country is out of work, whereas 20 per cent is normal for this time. Conditions are worst in New York City, where the seasonal influx of laborers has found steady work scarce and even snow-shoveling not to be had.

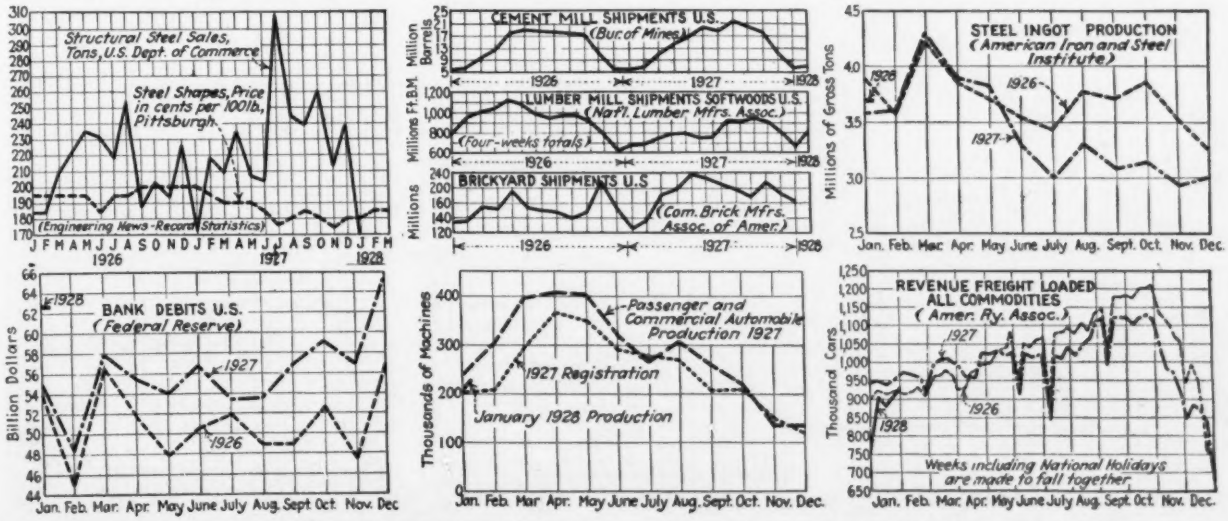
According to the Bureau of Labor Statistics, printing and paper is the only one of the twelve groups it surveys that had a greater number of men employed during January, 1928, than the average number on its payroll during 1923. All other groups show declines of 10 per cent or more. Those chiefly affected are unskilled laborers, clerical, clothing workers, coal miners and miscellaneous factory workers.

Employment in the manufacturing industries is now about 10 per cent above the low period of 1921, and comparable with conditions in the summer of 1924. Reduction in the number employed has amounted to 917,000 since 1923. The trend in factory employment has been definitely down since 1926.

Employment Situation Good in Ten Industries

In contrast to the foregoing, activity is abnormal in the following industries: Iron and steel, construction, automotive, electric light and power, electrical equipment, agricultural, railroads, rayon, tobacco and leather, with the first three leading.

Steel mills are operating at 85 per cent capacity, compared with 83 in January and 66 in December. Engineering construction is 15 per cent ahead of 1927 in value of contracts reported in Construction News. Public works contracts amount to 33 per cent of the total, compared with 30 per cent for the first two months of 1927. Automobile


Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, Price in cents per 100lb., Pittsburgh
(Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M
1926
1927
1928
CEMENT MILL SHIPMENTS U.S.
(Bur. of Mines)
Million Barrels
LUMBER MILL SHIPMENTS SOFTWOODS U.S.
(Nat'l. Lumber Mfrs. Assoc.)
(Four-weeks totals)
Millions Ft. B.M.
BRICKYARD SHIPMENTS U.S
(Com. Brick Mfrs. Assoc. of Amer.)
Millions
STEEL INGOT PRODUCTION
(American Iron and Steel Institute)
Millions of Gross Tons
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
BANK DEBITS U.S.
(Federal Reserve)
Billion Dollars
Passenger and Commercial Automobile Production 1927
1927 Registration
January 1928 Production
Thousands of Machines
REVENUE FREIGHT LOADED ALL COMMODITIES
(Amer. Ry. Assoc.)
Thousand Cars
Weeks including National Holidays are made to fall together.

PRODUCTION AND SHIPMENT OF BASIC MATERIALS—CHECKS CASHED AT BANKS—FREIGHT LOADINGS

sales continue to increase, as does the volume of unfilled orders.

In the building trades the only labor troubles reported in the last two months are a strike on a municipal contract in Union City, N. J., involving 200 men, and a walkout of twenty plasterers at Poughkeepsie, N. Y. Greater pressure is reported in favor of the five-day system, particularly in the West. St. Louis building trades are all on a 40-hour basis. Chicago painters demand the five-day week recently granted plasterers. Following is specific information from a number of cities:

New York painters feel unemployment more acutely than any other local trade. Fully half the union membership of 14,000 is out of work. With respect to general labor, there has been no unusual decrease in employment in the financial district. The Standard Oil Company of New Jersey is scheduled to drop 200 men from its Bayway refinery on March 1.

Birmingham has an oversupply of building trades mechanics. Reports of unusual construction activity have brought many men from other cities.

Detroit reports uninterrupted construction activity in the last two months.

Minneapolis reports normal unemployment of skilled labor.

Duluth—Wages in the building trades for 1928 will remain as they were in 1927, according to a decision of the Duluth Builders' Exchange. The open shop plan of employment inaugurated by the Minnesota Building Employers' Association in 1921 is reported to have effected a saving of 10 to 25 per cent. There have been no strikes or lockouts during the last seven years. Employers have dealt directly with their employees or apprentices to meet the requirements of each trade.

The average skilled labor rate for the nation remains $1.33⅜, which is the same as a year ago. The average common labor rate is the same as in February, 54¾ cents, compared with 56 cents in March, 1927. Following are the hourly wage changes of the month.

	March	February
Bricklayers,		
Atlanta	$1.25@$1.40	$1.40
Carpenters,		
Atlanta	0.60@ 0.70	0.70
Birmingham	1.00	1.05
Hodcarriers,		
Birmingham	0.50	0.50@0.75
San Francisco	0.87½	1.00
Common laborers,		
Montreal	0.25@ 0.30	0.30@0.35

CURRENT BUILDING TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.00	.50	.....	1.75	.30@.35
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.37½	1.37½	.97½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.50	1.00@1.50	.90@.96¼	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.25	.30@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.31¼@.50
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.35@.75
Los Angeles	1.37½	1.00	(1.00)	.81¼	1.12½	1.00	.50
Minneapolis	1.37½	.87½@.95	.87½	.75	.....	1.00	.45@.60
Montreal	1.12	.75	.75	.45	.50	.75	.25@.30
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90¾
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	1.37½@1.56	1.12½	.....	1.50	.50@.50
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½@1.25	.62½@.70

General Prices Steady; Some Building Materials Rise

Prices of the principal commodities at wholesale show a slight excess of declines over advances at the main distributing centers throughout the country. The general effect, however, is a wholesale price level practically unchanged from that of a month ago or that of one year ago.

Consistent gains during the last month and also as compared with a year ago are found in the following commodities: leather, woolen textiles, chemicals, farm products, furniture and foods.

Declines occurred in non-ferrous metals, coal, coke, petroleum products, drugs, pharmaceuticals, fertilizers, rubber and textiles other than woolen.

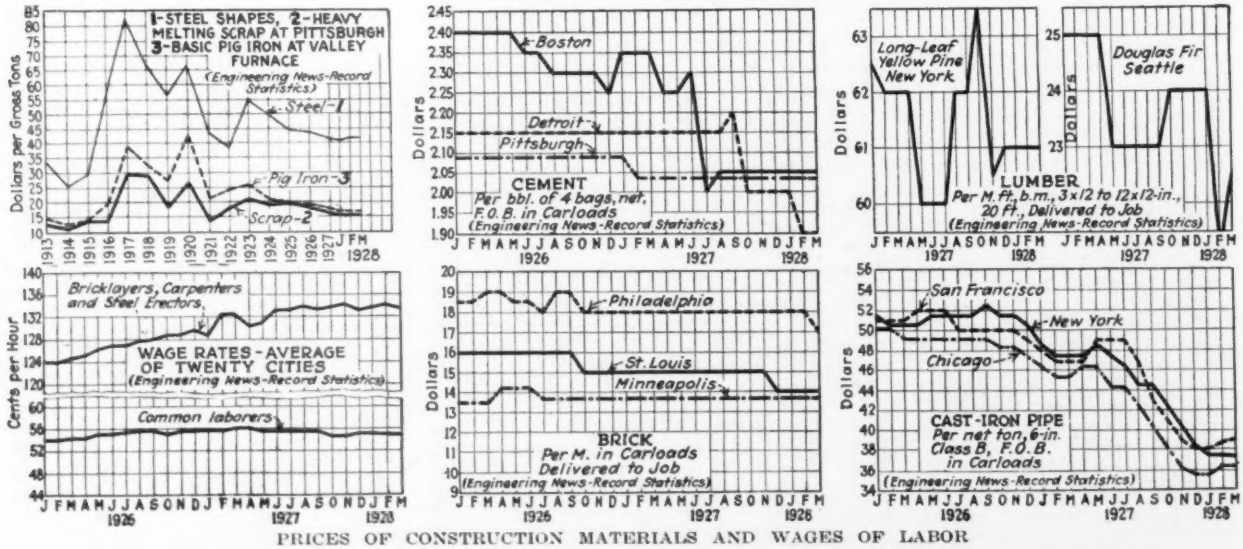
Tendency to grant price concessions also appears in the retail trade. Present limited reserve stocks, however, will serve to prevent abrupt price declines.

Construction materials, constituting one of the chief groups, have declined in easy stages since November, 1926. March opens with an upward movement in prices of such materials as steel, sewer pipe, tile, Douglas fir, brick, paint materials and manila rope. Cast-iron pipe and window glass declined from February levels; cement held firm.

Of particular interest is the continued advance in the price of steel shapes at Pittsburgh mills; the latest, effective Feb. 23, brings the price to $1.90 per 100 lb. in carloads, with small lots $2. The price had advanced from $1.75 on Nov. 1 to $1.80 in December and January to $1.85 on Feb. 1.

While sewer pipe at warehouses in the various cities shows little change from February prices, the manufacturers' advances now going into effect will influence delivered quotations later.

Dealers quite generally report that February deliveries of building materials to job were in comparatively small volume, that reserve stocks are light and that a substantial backlog of orders assures active March shipments.



PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type;** declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern (silicon 2.25@2.75)	$21.44
Northern Basic	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19
NEW YORK, tidewater delivery	
Southern No. 2 (silicon 2.25@2.75)	25.62
BIRMINGHAM	
No. 2 Foundry (silicon 2.25@2.75)	16.00
PHILADELPHIA	
Eastern Pa., No. 2X (2.25@2.75 sil.)	21.76
Virginia No. 2 (silicon 2.25@2.75)	27.17
Basic	21.26
CHICAGO	
No. 2 Foundry Local (silicon 1.75@2.25)	20.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80
PITTSBURGH, including freight charge ($1.76) from the Valley	
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26
Basic	19.26
Bessemer	21.26

SCRAP—The prices following are f.o.b. per gross ton paid by dealers:

	Pittsburgh	New York	Chicago*
No. 1 railroad wrought	$11.00@$11.50	$10.50@$11.00	**$11.25@$11.75**
Stove plate	.....	8.75@ 9.00	12.25@ 12.75
No. 1 machinery cast	14.50	**13.00@** 14.00	*13.75@ 14.25*
Machine shop turnings	11.00@ 11.50	6.75@ 7.50	7.50@ 8.00
Cast borings	11.00@ 11.50	6.75@ **7.50**	*8.50@* 9.00
Railroad malleable	14.75@ 15.25	10.00@ 10.50	**11.50@ 12.00**
Re-rolling rails	.....	10.50@ 11.00	13.00@ 13.50
Re-laying rails	.....	23.00@ 24.00	.....
Heavy melting steel	14.75@ 15.25	**7.00@** 10.75	**11.25@ 11.75**
Iron and steel pipe	.....	8.75	.....

* Net ton.

Railway Supplies

STEEL RAILS—The following quotations are per gross ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	$49.50
Light rails, 8 to 10 lb.	.....	34@36	1.80@1.90*	1.85*
Light rails, 12 to 14 lb.	.....	34@36	1.80@1.90*	1.765*
Light rails, 25 to 45 lb.	36.00	34@36	1.80@1.90*	1.72*
Re-rolled rails	30@32	34@36	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft
Chicago, white oak, plain	$1.40	$1.78
Chicago, empty cell creosoted	1.80	2.40
Chicago, zinc treated	1.60	2.10
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	**$2.75** 2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	*2.95*	3.40	4.25	4.25	2.95
Tie plates	2.25	.....	.....	.....	.....

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13
LAP WELD					
1	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
2 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list, hold for welded steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

WROUGHT STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches—External	Diameter in Inches—Internal	Thickness Inches
⅛	$0.17	1.315	1.049	.133
¼	.23	1.66	1.38	.14
⅜	.27½	1.9	1.61	.145
½	.37	2.375	2.067	.154
¾	.58½	2.875	2.469	.203
1	.76½	3.5	3.068	.216
1¼	.92	4.0	3.548	.226
1½	1.09	4.5	4.026	.237
2	1.27	5.0	4.506	.247
2½	1.48	5.563	5.047	.258
3	1.92	6.625	6.065	.28

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier, f. o. b., in carload or larger lots:

	Birmingham	Burlington, N. J.	New York
4 in.	*$30.00*	*$37.00*	*$39.60*
6 in. and over	*27.00*	*34.00*	*36.60*
	Pittsburgh	**Chicago**	**St. Louis**	**San Francisco**
4 in.	*$38.50*	*$38.20*	*$35.60*	*$41.00*
6 in. and over	*35.50*	*35.20*	*32.60*	*38.00*

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$35.00	$45.00	.....	$73.00
4	56.00	35.00	56.00	$76.50	90.00
5	.....	.....	80.00	97.75	118.00
6	90.00	65.00	100.00	127.50	150.00
8	150.00	150.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe, 12-in., in carloads, f.o.b., except as otherwise stated:

Atlanta	$0.425	Los Angeles	$0.5085*
Baltimore	.3915	Montreal (delivered)	.75
Birmingham	.54	Minneapolis	.45
Boston	.47	New Orleans	.4675
Cincinnati	.4725	New York (delivered)	.61
Chicago	**.351**	Philadelphia	.38
Dallas	.70	Pittsburgh	.3375
Denver	.47	St. Louis	.36*
Detroit	.405	San Francisco	.56
Kansas City, Mo	.52	Seattle	.63

* Double strength.

Road and Paving Materials

ROAD OILS—Following are prices per gal. in tank cars, 8,000 gal. minimum f.o.b., places named:

New York, 45% asphalt	(at terminal)	$0.0725@ $0.075
New York, 65% asphalt	(at terminal)	.0675@ .0725
New York, binder	(at terminal)	.07 @ .075
New York, flux	(at terminal)	.07 @ .075
New York, liquid asphalt	(at terminal)	.07 @ .075
St. Louis, 40@50% asphalt		.052
St. Louis, 50@60% asphalt		.0554
Birmingham, 55% asphalt		.0475
Dallas, 45% asphalt		.0495
Dallas, 50% asphalt		.0455
Dallas, binder		.061
San Francisco, binder, per ton		12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	24.00	$19.00
Chicago (*Texas*)	24.00	18.50
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities* (*Standard*)	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	*21.50*
Atlanta (*Mexican*)	**24.55**	**20.40**
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, M.. (*Texas*)	28.30	24.30
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton. Drums used in New York.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	2.40 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, per lin.ft., f.o.b. barge, New York, 5x16 in., 90c. *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft.; roundings, *$1.35* per lin.ft. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK, PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.45
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.30
St. Louis	4	16	2.55
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Prices are in truckloads, per cu.yd. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
New York (*alongside dock*)	$1.75	$1.75	$1.00
Denver (*2,700*)	1.50	1.50	.75‡
Chicago	*2.25*†	*2.25*†	*2.25*†
St. Louis	1.45*	1.45*	1.20*
Seattle (*3,200*) (*2,850*)	1.00	1.00	1.00
Dallas	2.38	2.38	2.00
Minneapolis (*2,800*)	1.25*	1.25*	1.25†
Cincinnati	1.30*	1.30*	1.05*
San Francisco (*2,800*)	1.80	1.80	1.40
Boston (*on trucks at dock*)	1.75*	1.75*	1.25*
New Orleans (*2,700*) (*2,500*)	1.95*	1.95*	1.40*
Los Angeles	2.10*†	2.10*†	1.40*†
Atlanta	.....	.....	**2.02**
Detroit (*2,600*)	1.70	1.60	1.35
Baltimore	1.40	1.60	.70‡*
Montreal	1.90*	1.50*	*1.20**
Birmingham (*2,700*)	1.54	1.54	1.19
Philadelphia (*2,950*)	2.25	2.25	1.65
Kansas City, Mo.	.....	.....	.66‡*
Pittsburgh	.85‡*	1.05‡*	1.25*

*Per ton. †Delivered. ‡At pit. Note: New York gravel weighs 2,800@ 3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are in truckloads, per cu.yd. Weight 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
New York (*L*)	$1.75	$1.85
Chicago (*L*)	*2.25*†	*2.25*†
St. Louis	1.73*	1.73*
Dallas	2.30	2.75
San Francisco (*T*) (*2,400*)	1.70	1.70
Boston (*on trucks at dock*)	2.00*	2.00*
Minneapolis (*L*) (*2,600*)	1.25*	1.25*
Kansas City (*L*) (*2,450*)	1.35*	1.35*
Denver (*G*) (*2,700*)	2.50	2.50
Seattle (*2,700*)	1.90	1.90
Atlanta	.....	.....
Cincinnati	1.65*	1.65*
Los Angeles	2.10*†	2.10*†
Detroit (*L*) (*2,600*)	2.60*	2.60*
Baltimore	2.50	2.55
Montreal	*1.60**	1.75*
Philadelphia (*L*) (*2,590*)	2.25	2.25
Pittsburgh	2.75*	2.75*
Cleveland	2.70*	2.70*
Birmingham (*L*)	.85‡	1.00‡

*Per ton. †Delivered. ‡At Crusher. *L*-Limestone. *G*-Granite. *T*-Trap rock.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse or wholesale prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$17.20@18.20	$12.10	$3.25@$3.50*	$2.10@2.50*
Chicago (*del.*)	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	18.50	12.00	3.50*	2.25@2.50*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco (*del.*)	27.50	24.50	.....	1.70†
Minneapolis (*del.*)	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.50	11.50	.....	12.00‡
Seattle, *paper sacks*	24.00	.....	.....	2.80*
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	13.00	2.55†	.....
Montreal	.....	21.00	.....	**12.00**‡
Atlanta	**25.00**	**15.00**	.....	1.25†
New Orleans	.....	.....	.....	2.00*
Philadelphia	23.00	15.00	.....	.....
Kansas City	28.00	24.00	2.66*	2.50*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

Minneapolis (Rosendale)	$2.80
Kansas City (Ft. Scott)	*1.35*
Cincinnati (Utica)	1.72
Boston (Rosendale)	2.45
St. Louis (Carney)	2.65
Birmingham (Magnolia) pozzolan cement	2.40

PORTLAND CEMENT—Prices to contractors, per bbl. in carload lots, f.o.b points listed, *without charge for bags*. Cash discount not deducted.

New York, del. by truck	$2.25@$2.35	San Francisco	2.41
New York, alongside dock to dealers	2.03	New Orleans	2.07
Jersey City	2.13	Minneapolis	2.22
Boston	2.05	Denver	2.85
Chicago	2.05	Seattle	2.65
Pittsburgh	2.04	Dallas	2.05
Cleveland	2.24	Atlanta	*2.15*
Detroit	1.90	Cincinnati	*2.22*
Indianapolis	2.19	Los Angeles	2.50
Milwaukee	2.20	Baltimore	2.50
Duluth	2.04	Birmingham	2.40
Peoria	2.22	Kansas City, Mo.	2.10
Cedar Rapids	2.24	Montreal	1.41
Davenport	2.24	Philadelphia	2.40
St. Louis	2.05	St. Paul	2.22
		Toledo	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.65
Steelton, Minn.	1.85	Hannibal, Mo.	1.90
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	1.65
Iola, Kan.	1.85	Alpena, Mich.	1.60
Mason City, Ia.	1.80	Kingsport, Tenn.	2.05
La Salle, Ill.	1.90	Clinchfield, Ga.	1.65
		Richard City, Tenn.	$1.85

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse, in lots of 10,000 sq.ft. or over.

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York*	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	....
180	78	3.35	3.43	4.73	3.60	3.47	....
245	103	4.43	4.53	6.24	4.75	4.58	....
287	119	5.12	5.24	7.20	5.50	5.26	6.35
336	138	5.93	6.07	8.36	6.37	6.11	....
1395	160	6.88	7.04	9.68	7.38	7.12	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. *Delivered to job. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Per 100 yd., painted, in less-than-carload lots

Weight in Pounds per Yd.	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$18.00	$21.00	$18.00	$16.50	$17.00	$22.00
2.5	19.00	22.00	19.00	17.50	19.00	23.50
3.0	21.00	24.50	21.00	20.00	22.00	26.50
3.4	22.50	26.50	22.50	21.50	24.00	29.00

BARS, CONCRETE REINFORCING—Pittsburgh price is in carloads, per 100 lb., f.o.b. mill. In other cities listed, prices are per 100 lb., for bars out of stock at warehouse.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
½ and larger	$1.90	$2.00	$3.24	$2.30	$3.15	$2.75	$2.95
⅜	2.00	2.10	3.34	2.40	3.25	2.85	3.05
¼	2.10	2.20	3.44	2.50	3.35	2.95	3.15
⅛	2.30	2.40	3.64	2.70	3.55	3.10	3.35
⅛	2.90	3.00	4.24	3.30	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

BRICK—Contractors price, f.o.b., per M, in cargo or carload lots, is as follows:

	Common	Paving: 3x8½x4-in.	Paving: 3½x8½x4-in.
New York (del.*)	$16@18	$45.00†	$51.00†
New York (at dock)	14.00	.....	.....
Chicago	12.00	42.00	45.00
St. Louis, salmon (del.)	14.00	40.00	42.50
Denver, salmon	8@12	.....	.....
Dallas	13.50	35.00	.....
San Francisco	13.00	.....	.....
Los Angeles	10.00	(not used)	
Boston (del.)	17.50	45.00	*52.50*
Minneapolis (del.)	*13.50*	.....	.....
Kansas City	14.00	45.00	55.00
Seattle	14.00	.....	55.00
Cincinnati	15.50	40.00	45.00
Montreal (del.)	*18.50*	100.00‡	.....
Detroit (del.)	15.50	35.50	38.50
Baltimore	18.00	40.00	45.00
Atlanta	**12.00**	40.00	.....
New Orleans	14.00	60.00	75.00
Birmingham	**15.50**	40.00	45.00
Philadelphia (del.)	17.00	40.00	50.00
Pittsburgh (del.)	17.00	.....	.....
Cleveland	14@16	.....	.....

* By truck. † In cars. ‡ Imported.

HOLLOW TILE—Price of hollow building tile per block to contractors in lots of 2,000 pieces or over:

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.14	$0.235
Minneapolis	**.0741**	**.1356**	*.219*
Cincinnati	.064	.1295	.1726
Kansas City	.076	.138	.214
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.0808	.1516	.2232
Detroit	.068	.1326	.1853
Montreal	.12	.22	.315
Baltimore	.124	.268	....
Atlanta	**.0724**	**.1358**	....
Dallas	.103	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.06	.12	....
New York*†	**.1004**	**.1883**	**.312**‡
Chicago	.076	.142	.202
Philadelphia	**.11**	**.22**	**.34**
St. Louis	.068	.126	.186
San Francisco	.108	.244	....

* 5 per cent off for cash. † Partition tile on trucks. ‡Perth Ambay, N. J.

STRUCTURAL MATERIAL—Pittsburgh price is in carloads, per 100 lb., f.o.b. mill. At other cities listed, quotations apply on less-than-carload lots from warehouses:

	Pittsburgh	Birmingham	Warehouse: New York	Warehouse: Dallas	Warehouse: St. Louis	Warehouse: Chicago	Warehouse: San Francisco
Beams, 3 to 15 in.	**$1.90**	$1.90@$2.00	$3.34	$4.00	$3.25	$3.10	$3.15
Channels, 3 to 15 in.	**1.90**	1.90@ 2.00	3.34	4.00	3.25	3.10	3.15
Angles, 3 to 6 in., ¼ in. thick	**1.90**	1.90@ 2.00	3.34	4.00	3.25	3.10	3.15
Tees, 3 in. and l'rg'r.	**1.90**	1.90@ 2.00	3.34	4.00	3.35	3.10	3.15
Plates, ¼ in. thick and heavier	**1.90**	1.90@ 2.00	3.34	4.00	3.25	3.10	3.15

RIVETS—The following quotations are per 100 lb.:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York	Warehouse: Chicago	Warehouse: St. Louis	Warehouse: San Francisco	Dallas
½ in.	$2.75	$5.00	$3.60	$3.75	$5.75	$4.75

CONE-HEAD BOILER

½ in.	$3.10@3.25	$5.00	$3.60	$3.90	$5.75	$5.00

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	**$2.65**	2.85	$2.95	**$3.40**	$4.25	$2.83	$4.95
Cut	2.80	2.90	....	4.90	5.00	2.88	5.00

SHIP SPIKES—Current prices per 100 lb:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.30	$5.55	$7.75
⅜	6.85	5.10	5.65
½	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, **$3.25.**

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93¾ per square to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tarred felt per 100 lb.	$2.94½
Asphalt coating, per gal.	31½
Asphalt felt, per 100 lb.	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 90 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 90 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.10	$3.60	$3.50	$3.75	$3.89
No. 12	2.15	3.65	3.55	3.80	3.94
No. 14	2.20	3.70	3.60	3.85	3.99
No. 16	2.30	3.80	3.70	3.95	4.09
Black					
Nos. 18 to 20	2.70	4.25	3.75	4.60	4.00
No. 22	2.85	4.40	3.90	4.75	4.15
No. 24	2.90	4.45	3.95	4.80	4.20
No. 26	3.00	4.55	4.05	4.90	4.30
No. 28	3.15	4.70	4.20	5.05	4.45
Galvanized					
No. 10	$2.95@3.05	4.55	4.10	4.65	4.25
Nos. 12 to 14	3.05@3.15	4.65	4.20	4.75	4.35
No. 16	3.15@3.25	4.75	4.30	4.85	4.45
No. 18	3.30@3.40	4.90	4.45	5.00	4.60
No. 20	3.45@3.55	5.05	4.60	5.15	4.75
No. 22	3.50@3.60	5.10	4.65	5.20	4.80
No. 24	3.65@3.75	5.25	4.80	5.35	4.95
No. 26	3.90@4.00	5.50	5.05	5.60	5.20
No. 28	4.15@4.25	5.75	5.30	5.85	5.45

LINSEED OIL—These prices are for raw oil in barrels, 5-bbl. lots:

	New York	Chicago	Minneapolis
Per 7½-lb. gallon	$0.76½	$0.78	$0.85½

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

Lumber

Prices wholesale, per M. ft. b.m., f.o.b. in carloads.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$30.00	$31.00
3x6 and 8	30.00	31.00
3x10 and 12	30.00	31.00
3x14	33.00	34.00

CHICAGO—Prices per M. ft. b.m.:

	20 Ft. and Under No. 1 Long Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$38.00	$39.50
3x10 to 10x10	45.00	39.50
3x12 to 12x12	55.00	39.50
3x14 to 14x14	.....	39.50
3x16 to 16x16	.....	40.50

New York—Wholesale prices per M. ft. b.m. to dealers:

	20 Ft. and Under Long Leaf Yellow Pine	22-24 Ft. Long Leaf Yellow Pine
3x4 to 8x8	$41.00@43.00	$42.00@44.00
3x10 to 10x10	48.00@50.00	49.00@51.00
3x12 to 12x12	55.00@57.00	56.00@58.00
3x14 to 14x14	63.00@65.00	64.00@66.00
3x16 to 16x16	75.00@77.00	76.00@78.00

Prices are for long-leaf yellow pine timbers (rough) to dealers, alongside dock. Price to contractors, delivered by trucks from lighters to job, $5@$10 additional. Short leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—On cars or at dock:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hem.	Spruce	Pine*	Fir†
Boston	$48.00	$47.50	$49.00	$52.00	$57.50	$57.00
Seattle	.....	24.00	.....	.....	.....	**22.50**
New Orleans	45.00	.....	.....	.....	46.50	.....
Baltimore	35.00	49.25	53.00	60.00	74.00	49.75
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	49.00	*46.00*
Los Angeles	.....	32.00	.....	32.00	.....	32.00
Denver	.....	32.75	32.75	32.75	33.75	33.75
Minneapolis	44.25	37.75	36.25	.....	48.25	38.25
Atlanta	31.00	.....	.....	.....	45.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	40.50	38.75	.....	.....	54.50	38.75
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	48.00	35.00	40.00	45.00	60.00	35.00
Detroit	42.00	40.50	.....	.....	56.00	40.50
St. Louis	40.00	.....	.....	.....	51.50	.....

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir.†	Hem.	Pine*	Fir†
Boston	$43.50	$43.00	$44.50	$48.50	$48.00
Seattle	.....	22.00	.....	.....	23.50
New Orleans	30.00	.....	.....	40.00	.....
Baltimore	55.00	44.00	44.00	34.00	49.50
Cincinnati	27.00	32.00	30.00	28.50	45.00
Montreal	45.00	*48.00*	40.00	65.00	50.00
Los Angeles	.....	24.50	.....	.....	36.00
Denver	.....	32.75	33.25	.....	31.75
Minneapolis	39.75	35.25	34.75	33.75	33.25
Atlanta	40.00	.....	.....	40.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	50.75	38.75	.....	40.00	36.75
Birmingham	27.00	.....	.....	*40.00*	.....
Philadelphia	32.00	35.00	37.00	50.00	35.00
Detroit	40.50	37.00	.....	30.50	41.25
St. Louis	39.00	.....	.....	27.50	.....

* Long-leaf yellow pine. † Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 99 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The base-price f.o.b. Pittsburgh is $2.20@$2.25 per 100 lb.

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	18@.20
New Orleans	....	Minneapolis, (f.o.b.)	.14
Brooklyn and Queens	.18	Philadelphia	18@.20
Pittsburgh	.18		

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (*add to list*)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft.; ½-in., 6; ⅝-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following are prices per pound for ½-in. and larger, in 1200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.26	Los Angeles	.25
Chicago	.22	Seattle	.23
Minneapolis	.24	St. Louis	.23
San Francisco	.23½	Montreal	.24½
Atlanta	.22	Detroit	.24½
Denver	.24@.25	Baltimore	.26
Cincinnati	.21	Kansas City	.24
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound for dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.24	.27
Kansas City	.22	.225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.245	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

* Special gelatin in case lots. † Quantities above 500 lb., but less than a ton.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.00@ 5.10
Soda ash, 58%, in bags, per 100 lb	1.32@ 1.35
Chlorine, liquid, cylinders, per lb	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10*

* F.o.b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.